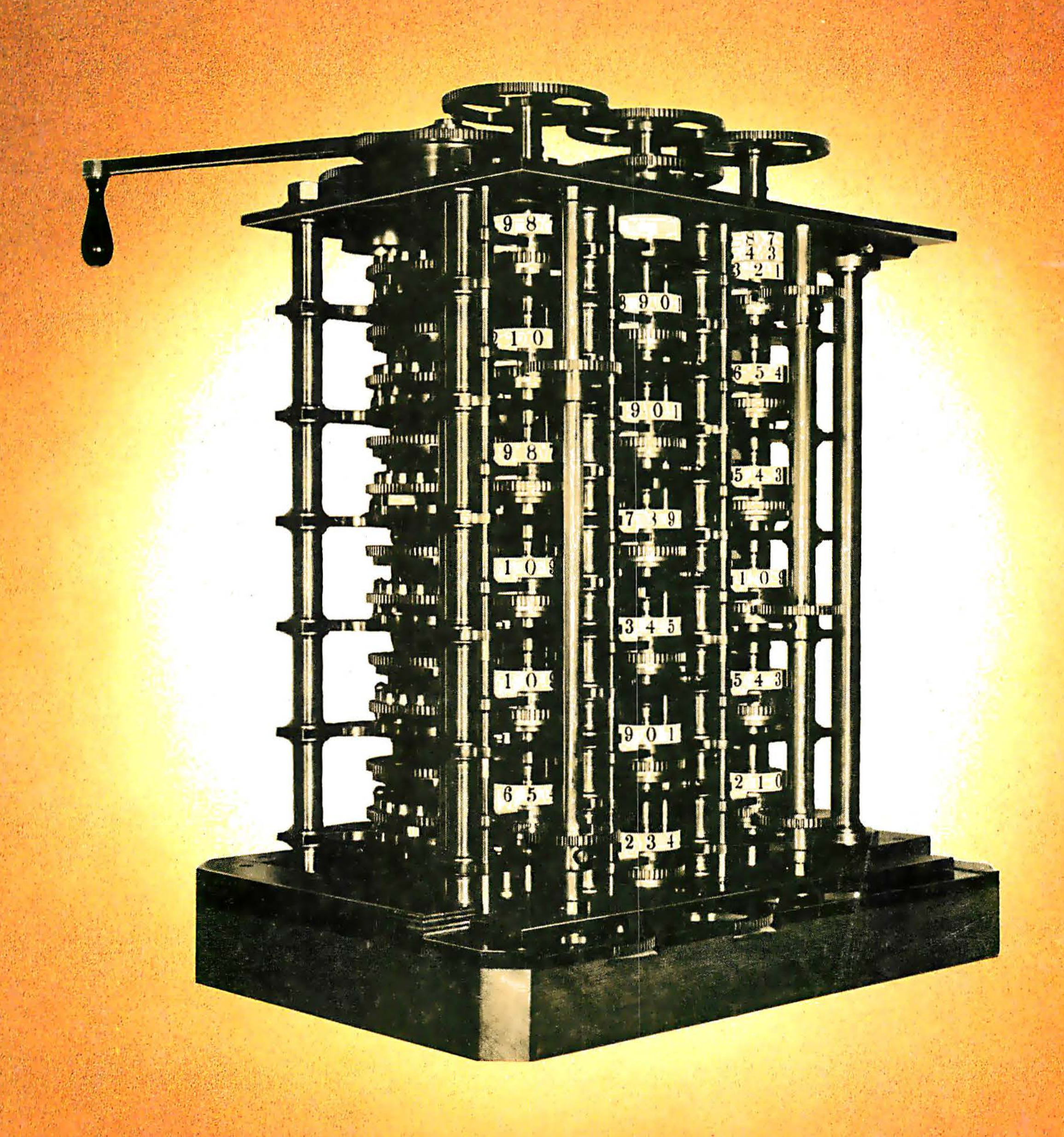
JULY 1978 VOLUME 3, Number 7

$2.00 in USA

$2.40 in CANADA

BYTE

the small systems journal



SwTPC MULTI-USER SYSTEM

OPERATES – Up to 4 terminals running INDEPENDENT programs

HARDWARE TIME SHARE – Requires no modifications to computer

IDEAL FOR – All multi-terminal applications

The SwTPC multi-user system converts our standard 6800 single user computer into a multi-user time share system that may be operated with up to four terminals. The four terminals operate independently and may be running four different programs.

No modifications to the computer are necessary, you simply plug in the multi-user board and add an interface for each additional terminal.

The multi-user system is ideal for program training, multi-station business applications and for computer aided instruction (CAI). Speed reduction from a single user system is negligible because all switching is done in hardware.

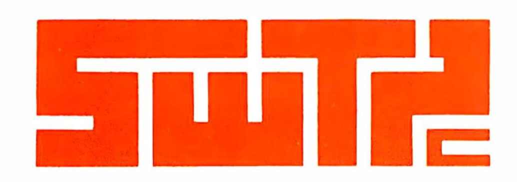
Multi-user BASIC, suitable for program instruction and simple business applications, is included with the multi-user board. An 8K disc BASIC is also available for systems in which disc drives are used. This software has a complete nine digit floating point math package, full string features and data files.

For computer aided instruction applications, a full feature version of PILOT is available. It includes math operators, misspelling match features and all other proposed for the ANSII standard version. The 6800 multi-user system is just as economical, but far more flexible and powerful than multiple small machines for CAI applications.

MUB-68 Multi-User Board and BASIC Software

Assembled and tested. $150.00

Kit $129.95



SOUTHWEST TECHNICAL PRODUCTS CORPORATION

219 W. RHAPSODY

SAN ANTONIO, TEXAS 78216

Circle 350 on inquiry card.



Model Z-2
Up to 512K of RAM/ROM



Model Z-2D
One or two disks
Up to 512K of RAM/ROM
Up to 184K of disk



System Two
Dual disk
Up to 512K of RAM/ROM
Up to 184K of disk

Fill your computer needs with the industry's most professional microcomputers

#1 IN RELIABILITY

When you choose Cromemco you get not only the industry's finest microcomputers but also the industry's widest microcomputer selection.

What's more, you get a computer from the manufacturer that computer dealers rate #1 in product reliability.*

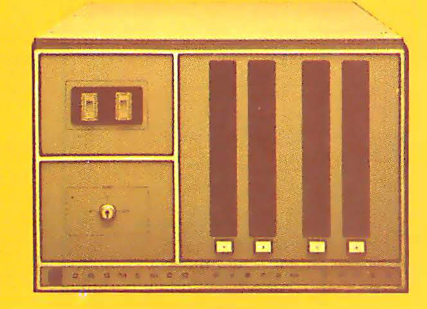
Your range of choice includes our advanced System Three with up to four 8″ disk drives. Or choose from the System Two and Z-2D with 5″ drives. Then for ROM-based work there's the Z2. Each of these computers further offers up to ½ megabyte of RAM (or ROM).

We say these are the industry's most professional microcomputers because they have outstanding features like these:

- **Z-80A microprocessor — operates at 250 nano second cycle time — nearly twice the speed of most others.**

*Rated in ***The 1977 Computer Store Survey*** by Image Resources, Westlake Village, CA.

Up to 512 kilobytes of RAM and 1 megabyte of disk storage



System Three
Two to four disks
Up to 512K of RAM/ROM
Up to 1 megabyte of disk

- **21 card slots to allow for unparalleled system expansion using industry-standard S-100 cards.**
- **S-100 bus — don't overlook how important this is. It has the industry's widest support and Cromemco has professionally implemented it in a fully-shielded design.**
- **Cromemco card support of more than a dozen circuit cards for process control, business systems, and data acquisition including cards for A-D and D-A conversion, for interfacing daisy-wheel or dot-matrix printers, even a card for programming PROMs.**
- **The industry's most professional software support, including FORTRAN IV, 16K Disk-Extended BASIC, Z-80 Macro Assembler, Cromemco Multi-User Operating System — and more coming.**
- **Rugged, professional all-metal construction for rack (or bench or floor cabinet) mounting. Cabinets available.**

FOR TODAY AND TOMORROW

Cromemco computers will meet your needs now and in the future because of their unquestioned technical leadership, professionalism and enormous expandability.

See them today at your dealer. There's no substitute for getting the best.


see next page



Cromemco
incorporated
Specialists in computers and peripherals
280 BERNARDO AVE., MOUNTAIN VIEW, CA 94040 • (415) 964-7400

Circle 80 on inquiry card.

SEE YOUR LOCAL DEALER

Anchorage, AK 99502
ALASKA DIVERSIFIED DIGITAL
1700 West Hoteco Avenue
(907) 277-6312

Huntsville, AL 35805
COMPUTERLAND OF HUNTSVILLE
3020 University Drive, N.W.
(205) 539-1200

• LittleRock, AR 72206
COMPUTER PRODUCTS UNLIMITED
2412 South Broadway
(501) 371-0449

Phoenix, AZ 85013
BYTE SHOP OF PHOENIX
24 W. Camelback Rd.
(602) 265-0065

Phoenix, AZ 85021
COMPUTER RESEARCH CORP.
2225 W. Mtn. View Road – No. 6
(602) 943-8719

Phoenix, AZ 85029
COMPUTER WORLD
2230 West Larkspur
(602) 943-8925

Tucson, Arizona 85716
BYTE SHOP OF TUCSON
2612 East Broad way
(602) 327-4579

• Carson, CA 90746
SUNSHINE COMPUTER COMPANY
20710 South Leapwood Avenue
(213) 327-2118

• Citrus Heights, CA 95610
BYTE SHOP SACRAMENTO
6041 Green back Lane
(916) 961-BYTE

El Cerrito, CA 94530
COMPUTERLAND EL CERRITO
11074 San Pablo Avenue
(415) 233-5010

• Fountain Valley, CA 92708
ADVENTURES IN COMPUTING
8756 Warner Avenue
(714) 848-8388

Fresno, CA 93703
BYTE SHOP OF FRESNO
3139 E. McKinley Avenue
(209) 485-2417

Hayward, CA 94542
COMPUTERLAND OF HAYWARD
22634 Foothill Boulevard
(415) 538-8080

Huntington Beach, CA 92647
ALGORITHM PERSONAL COMPUTERS
7561 Rhine Drive
(714) 751-8080

Inglewood, CA 90302
COMPUTERLAND OF W. LOS ANGELES
6840 La Cienega Boulevard
(213) 776-8080

Lawndale, CA 92060
BYTE SHOP OF LAWNDALE
6508 Hawthorne Boulevard
(213) 371-2421

• Loomis, CA 95650
KINGMONT ENTERPRISES, INC.
9900 King Road
(916) 988-8189

Los Angeles, CA 90025
AMERICAN RECORDER COMPANY
1655 Sawtelle Boulevard
(213) 477-2063

MenloPark, CA 94025
COMPUTADATA PROCESSING SERVICE
2225 Sharon Road – No. 224

Mission Viejo, CA 92630
COMPUTERLAND SADDLEBACK VLY
24001 ViaFabricante – No. 904
(714) 770-0131

Moraga, CA 94556
ACCOUNTING BY COMPUTER
1161 Larch Ave.
(415) 376-1730

• Mountain View, CA 94040
BYTE OF MT. VIEW
1063 W. El Camino Real
(415) 969-5464

Orange, CA 92667
COMPUTER MART
633-BWest Katella Boulevard
(714) 633-1222

Palo Alto, CA 94306
BYTE SHOP PALO ALTO
2227 El Camino Real
(415) 327-8080

Palo Alto, CA 94301
MICROTECH EXPORTS
912 CowperStreet
(415) 328-1712

Pasadena, CA 91101
BYTE SHOP PASADENA
496 South Lake Avenue
(213) 684-3311

Placerville, CA 95667
GRANITE BUSINESS SYSTEMS
670 Pleasant Valley Road
(916) 626-1161

Sacramento, CA 95816
MICROCOMPUTER APPLICATIONS SYS
2322 Capital Avenue
(916) 433-4944

San Diego, CA 92211
COMPUTERLANDOF SAN DIEGO
4233 Convoy Street
(714) 5609912

San Diego, CA 92111
THE COMPUTER CENTER
8205 Ronson Road
(714) 292-5302

San Francisco, CA 94105
COMPUTERLAND OF SAN FRANCISCO
117 Fremont Street
(415) 546-1592

• San Francisco, CA 94103
THE COMPUTER STORE OF S.F.
1093 Mission Street
(415) 431.0640

San Francisco, CA 94118
THE NETWORK:
495 Third Avenue – No. 8
(415) 221-1112

• DENOTES 'SYSTEM THREE' DEALER

San Jose, CA 95124
BYTE SHOP #3 of SAN JOSE
2626 Union Avenue
(408) 377-4685

San Jose, CA 95123
THE COMPUTER ROOM
124-H Blossom Hill Road
(408) 226-8383

San Jose, CA 95132
PLANE DATA WORKS
3584 MintoCourt
(408) 262-6566

San Leandro, CA 94577
COMPUTERLAND CORPORATION
14400 Catalina Street
(415) 895-9363

• San Mateo, CA 94401
COMPUTER TERMINAL
309 S. San MateoDrive
(415) 347-9894

• Santa Ana, CA 92705
ADVANCED MICROCOMPUTER PROD.
1310 East Edinger
(714) 558-8813

Santa Clara, CA 95051
THE BYTE SHOP OF SANTA CLARA
3400 El Camino Real
(408) 249-4221

Santa Monica, CA 90401
THE COMPUTER STORE
820 Broadway
(213) 451-0713

Sunnyvale, CA 94086
BYTE INDUSTRIES
930 W. Maude
(415) 739-8000

• Sunnyvale, CA 94086
RECREATIONAL COMPUTER CENTER
1324 South Mary Avenue
(408) 732-3108

Tustin, CA 92680
COMPUTERLAND OF TUSTIN
104 West First Street
(714) 544-0542

• Van Nuys, CA 91411
COMPUTER COMPONENTS
5848 Sepulveda Boulevard

Walnut Creek, CA 94596
BYTE SHOP COMPUTERS OF DIABLO VLY
2989 N. Main Street
(415) 933-6252

Englewood, CO 80110
BYTE SHOP OF ARAPAHO COUNTY
3463 South Acoma Street
(303) 761-6322

Fairfield, CT 06430
COMPUTERLAND OF FAIRFIELD
2475 Black Rock Turnpike
(203) 374-2227

Windsor Locks, CT 06096
THE COMPUTER STORE
63 South Main Street
(203) 627-0188

Newark, DE 19711
COMPUTERLAND OF NEWCASTLE CITY
Astro Shopping Center
Kirkwood Highway
(302) 738-9656

Ft. Lauderdale, FL 33334
BYTE OF FT. LAUDERDALE
1044 E. Oakland Park Blvd.
(305) 561-2983

Ft. Lauderdale, FL 33312
COMPUTERS FOR YOU, INC.
3608 W. Broward Blvd.
(305) 581-8945

• Ft. Meyers, FL 33901
MICRO COMPUTER SYSTEMS, INC.
12800 U.S. 41 South
(813) 481-3376

Plantation, FL 33317
COMPUTER AGE
1400 S.W. 70th Avenue
(305) 791-8080

• Tampa, FL 33609
MICRO COMPUTER SYSTEMS
144 S. Dale Mabry Avenue
(813) 879-4225

• Atlanta, GA 30340
ATLANTA COMPUTER MART
5091-B Buford Highway
(404) 455-0647

Marietta, GA 30060
EDUCATIONAL DATA SERVICES
79 Oxford Road

• Haiku, Maui, HI 96708
CAPACITY, INC.
P.O. Box A
(808) 575-2930

• Honolulu, HI 96815
COMPACT COMPUTERS
305 Royal Hawaiian, Ste. 407
(808) 373-2751

Kailua, Oahu, HI 96734
MICROCOMPUTER ENTERPRISES
1450 Mokulua Drive
(808) 261-3281

Arlington Heights, IL 60004
COMPUTERLAND ARLINGTON HTS.
50 East Rand Road
(312) 255-6488

Champaign, IL 61820
BYTE SHOP CHAMPAIGN
1602 S. Neil Street
(217) 352-2323

Chicago, IL 60632
BRONSON & BRATTON, INC.
5161 S. Millard Avenue
(312) 735-6200

Lisle, IL 60532
COMPUTER & CONTROL AFFILIATE
4315 Azalea, No. 401
(312) 968-6548

Lombard, IL 60148
MIDWEST MICROCOMPUTERS, INC.
708 South Main Street
(312) 495-9889

Naperville, IL 60540
ILLINI MICROCOMPUTERS
612 East Ogden Avenue
(312) 420-8813

Niles, IL 60648
COMPUTERLAND NILES
9511 N. Milwaukee Avenue
(312) 967-1714

Oak Lawn, IL 60453
COMPUTERLAND OF OAK LAWN
10935 South Cicero Avenue
(312) 422-8080

Rockford, IL 61101
IMPERIAL COMPUTER SYSTEMS
2105 – 23rd Avenue
(815) 226-8200

Schaumburg, IL 60195
DATA DOMAIN SCHAUMBURG
1612 East Algonquin Road
(312) 397-8700

• Bloomington, IN 47401
DATA DOMAIN
406 South College Avenue
(812) 334-3607

• Fort Wayne, IN 46805
DATA DOMAIN OF FORT WAYNE
2805 East State Boulevard
(219) 484-7611

Indianapolis, IN 46268
DATA DOMAIN OF INDIANAPOLIS
7027 Michigan Road
(317) 251-3139

West Lafayette, IN 47906
DATA DOMAIN OF WEST LAFAYETTE
219 West Columbia
(317) 743-3951

Mission, KS 66202
COMPUTER CENTER
5815 Johnson Drive
(913) 432-2983

Overland Park, KS 66206
PERSONAL COMPUTER CENTER, INC.
3819 W. 95th Street
(913) 649-5942

Lexington, KY 40501
DATA DOMAIN OF LEXINGTON
506-1/2 Euclid Avenue
(606) 233-3346

Louisville, KY 40222
COMPUTERLAND OF LOUISVILLE
813-B Lyndon Lane
(502) 425-8308

Louisville, KY 40220
DATA DOMAIN OF LOUISVILLE
3028 Hunsinger Lane
(502) 456-5242

Louisville, KY 40206
PRAGMATECH
2310 Mellwood Avenue
(502) 895-1230

• Burlington, MA 01803
THE COMPUTER STORE
120 Cambridge Street
(617) 272-8770

Concord, MA 07742
TRAIL EQUIPMENT COMPANY
67 Main
(617) 369-8643

College Park, MD 20740
INTELLIGENT BUSINESS MACHINES
7338 Baltimore Avenue, Suite 200
(301) 779-7998

• Pikesville, MD 21208
MODULAR SYSTEMS, INC.
4005 Seven Mile Lane
(301) 484-6322

• Rockville, MD 20852
COMPUTER WORKSHOP
1776 East Jefferson
(301) 468-0463

Rockville, MD 20855
COMPUTERLANDOF GAITHERSBURG
16065 Frederick Road, Route 355
(301) 948-7676

Silver Spring, MD 20901
C & M ENGINEERING, INC.
9318 Worth Avenue
(301) 589-3779

• Towson, MD 21204
COMPUTERS ETC.
13-A Allegheny Avenue
(301) 296-0520

Ann Arbor, MI 48104
NEWMAN COMPUTER EXCHANGE
1250 North Main Street
(313) 994-4445

Ann Arbor, MI 48104
THE COMPUTER STORE
310 East Washington
(313) 995-7616

Ann Arbor, MI 48104
UNITED MICROSYSTEMS CORP.
2601 South State Street
(313) 668-6806

• Berrien Springs, MI 49103
THE ABACUS
Route No. 1, Box 193,(Niles Avenue)
(616) 429-3034

Grand Rapids, MI 49508
JEPSAN, GROUP K
4706 Morningside Drive, S.E.
(616) 698-9057

Royal Oak, MI 48073
COMPUTER MART OF ROYAL OAK
1800 West 14 Mile Road
(313) 576-0900

Edina, MN 55435
COMPUTER DEPOT, INC.
3515 West 70th Street
(612) 927-5601

Chesterfield, MO 63017
COMPUTER SYSTEMS CTR ST. LOUIS
13461 Olive Boulevard
(314) 576-5020

Lake St. Louis, MO 63367
DATA DYNAMICS, INC.
1000 Lake Saint Blvd., Ste. 324
(314) 625-2400

Nashua, NH 03060
COMPUTERLAND OF NASHUA
419 Amherst
(603) 889-5238

Hoboken, NJ 07030
HOBOKEN COMPUTER WORKS
No. 20 Hudson Place
(201) 420-1644

• Iselin, NJ 08830
COMPUTER MART OF NEW JERSEY
501 RouteNo. 27
(201) 283-0600

Morristown, NJ 07960
COMPUTERLAND OF MORRISTOWN
2 De Hart Street
(201) 539-4077

Reno, NV 89502
BYTE SHOP OF RENO
4104 Kietzke Lane
(702) 826-8080

Buffalo, NY 14150
COMPUTERLAND OF BUFFALO
1612 Niagara Falls Boulevard
(716) 836-6511

• Buffalo, NY 14226
CORSON COMPUTER CORP., INC.
3834 Main Street
(716) 832-0662

De Witt, NY 13214
COMPUTER ENTERPRISES
3470 Erie Boulevard East
(315) 446-1284

Hewlett, NY 11577
LOUIS SCHAEFFER
319 Hamilton Avenue
(516) 374-1286

• Hollis, NY 11423
SYNCHRO-SOUND ENTERPRISES
193-25 Jamaica Avenue
(212) 468-7067

Ithaca, NY 14850
COMPUTERLAND OF ITHACA
225 Elmira Road
(607) 277-4888

New York City, NY 10016
BYTE SHOP EAST
130 E. 40th Street
(212) 889-4204

Rochester, NY 14609
COMPUTER HOUSE, INC.
721 Atlantic Avenue
(716) 654-9238

• Cincinnati, OH 45409
DIGITAL DESIGN
7694 Camargo Rd. (Madiera)
(513) 561-6733

Cincinnati, OH 45202
21ST CENTURY SHOP
16 Convention Way
Skywalk, Vine & Race
(513) 651-2111

Columbus, OH 43201
MIDWESTERN DIGITAL ELECTRONICS
80 West Lane Avenue, Suite 1
(614) 294-2991

• Dayton, OH 45409
DATA DOMAIN OF DAYTON
1932 Brown Street
(513) 223-2348

Kent, OH 44240
OHIO MICRO SYSTEMS
233 South Water Street
(216) 678-5202

Mayfield Heights, OH 44124
COMPUTERLAND OF CLEVELAND EAST
1288 Som Center Road
(216) 461-1200

Oklahoma City, OK 73106
HIGH TECHNOLOGY
1611 Northwest 23rd Street
(405) 528-8008

Beaverton, OR 97005
BYTE SHOP OF BEAVERTON
3482 S.W. Cedar Hills Boulevard
(503) 644-2687

Eugene, OR 97401
REAL OREGON COMPUTER CO.
205 West Tenth Street, P.O. Box 52
(503) 484-1040

• Tualatin, OR 97062
CREATIVE SYSTEMS
8101 S.W. Nyberg Road
(503) 638-8406

Allison Park, PA 15101
R. DON KRIGGER
9380 Springfield Drive
(412) 364-4945

Huntington Valley, PA 19006
MARKETLINE SYSTEMS, INC.
2337 Philmont Avenue
(215) 947-6670

King of Prussia, PA 19406
COMPUTER MART OF PENNSYLVANIA
550 De KalbPike (Route 202)
(215) 265-2580

Pittsburgh, PA 15237
ELECTRONICS PLACE
7250 McNight Road

Warwick, RI 02886
COMPUTER POWER, INC.
1800 Post Road
(401) 738-4477

• Columbia, SC 29205
BYTE SHOP OF COLUMBIA
2018 Green Street
(803) 771-7824

Memphis, TN 38101
COMPUTER STORE
2162 Courtland Place
(901) 274-1938

Nashville, TN 37206
COMPUTER WORLD
625 Main Street
(615) 244-6094

• Nashville, TN 37211
SURYA CORPORATION
5755 Nolensville Road
(615) 834-5638

Amarillo, TX 79109
COMPUTER CORNER, INC.
1800 South Georgia Sr., No. 3
(806) 353-4194

• Austin, TX 78731
COMPUTERS'N THINGS
2825 HancockDrive
(512) 453-5970

• Corpus Christi, TX 78411
MICRO SYSTEMS SERVICES, INC.
5301 Everhart, Space H – P.O. Box 6535
(512) 855-4516

• Dallas, TX 75243
COMPUSHOP
211 Keyston Park, 13933 North Central
(214) 234-3412

• Houston, TX 77057
COMPUTERLAND OF S.W. HOUSTON
6439 Westheimer
(713) 977-0909

• Houston, TX 77006
COMPUTERTEX
2300 Richmond Avenue
(713) 526-6934

Houston, TX 77036
INTERACTIVE COMPUTERS
7646-1/2 Dashwood, P.O. Box 36584
(713) 977-7037

• Houston, TX 77098
THEMOS
1853 Richmond Avenue
(713) 527-8008

Lubbock, TX 79412
COMPUTER MART OF W. TEXAS
3506 D Avenue, Q
(806) 765-7134

Richardson, TX 75080
THE MICRO STORE
634 South Central Expressway
(214) 231-1096

Provo, UT 84601
THE COMPUTER WORKS
735 South StateStreet, P.O. Box N
(801) 373-7522

Alexandria, VA 22304
COMPUTERS PLUS, INC.
678 S. Pickett Street
(703) 751-5656

McLean, VA 22101
COMPUTER SYSTEMS STORE
1984 Chain BridgeRoad
(703) 821-8333

Seattle, WA 98115
THE RETAIL COMPUTER STORE
410 N.E. 72nd Street
(206) 524-4101

• Appleton, WI 54911
SOUND WORLD, INC.
3015 W. Wisconsin Avenue
(414) 734-7698

Madison, WI 53711
THE MADISON COMPUTER STORE
1863 Monroe Street
(608) 255-5552

Milwaukee, WI 53208
MILWAUKEE COMPUTER STORE
4710 WestNorth Avenue
(414) 445-4280

• Racine, WI 53405
COLORTRON TV
2111 Lathrop Avenue
(414) 637-2003

• INTERNATIONAL •

Carnegie, Vict. Australia
SONTROM INSTRUMENTS
17 Arawatta Street
560-0358

Croydon, Vict., Australia, 3136
COMPUTER ART & EDUCATION
2 Stephen Crescent

Prahran, Victoria, Australia, 3181
GEMINI MICRO COMPUTERS
P.O. Box 99

West Perth, 6005, W. Aust'l'a
AUSTRALIAN COMPUTER PRODUCTS
1300 Hay Street
(09) 322-6497

• A-2401 Fishamend, Austria
KREBSGES. M.B.H.
Hainburger Strabe 34
022326818223

Calgary, Alberta, Canada
ROBO-TRONICS
509-16 Avenue N.W.
(403) 282-9496

Montreal, Quebec, Can. H3B 3C9
FUTUR BYTE, INC.
1191 Phillips Square
(514) 861-3120

Toronto, Ont., Can. M4G 3B5
COMPUTER MART, LTD.
1543 Bayview Avenue
(416) 484-9708

Toronto, Ont., Can. M4R 1A1
FIRST CANADIAN COMPUTER STORE
44 Eglinton Avenue West
(416) 482-8080

Toronto, Ont., Can. M5Y 121
TRINTRONICS, LTD.
186 Queen Street West
(416) 598-0260

Calgary, Alta., Can. T2T 4T9
THE COMPUTER SHOP
3515 Eighteenth Street, S.W.
(403) 243-0301

• Little Paxton, Huntingdon, Cambs.
Cambs., England PE19 4NJ
COMART LIMITED
24A Market Square
0480-215-005

Paris 75017, France
COMPUTER BOUTIQUE
149 Avenue de Wagram

Chiyoda-Ky, Tokyo 101, Japan
BYTE SHOP SOGOH
1-6-6 Sotokanda
03 255-1984

Kashiwa City Chiba Pf. 277, Japan
BELLKEY TEC. INC.
5-9,2-Chome Kaga

Tokyo 106, Japan
IEE CORPORATION
4-33, 3-Chome, Ropongi, Minatoka
(03) 5852333

• Mexico 18, D.F. Mexico
INTELEX, S.A.
P.A. De Los Santos 70
(905) 516-9970

Makati, Rizal, The Phillipines
DECISION SYSTEMS CORP.
150 Amorsnlo St. & Pasay Rd.
Legaspi Village

• 10052 Stockbolm 29, Sweden
DATORISERING KONSULT AB
Fack 2

4053 Basel, Switzerland
EUREX, INC.
Beinwiler Str. 13
061-357069

• 8003 Zurich, Switzerland
COMICRO AG
Badenerstrasse 281

• Hiltrup 4400, Munster, W. Germany
BASIS MICROCOMPUTER VERTRIEB
Von-Flotow-Strabe 5
02501-4800

• 2000 Wedel, Holstein, W. Germany
DIGITRONIC COMPUTERSYSTEME
Bei Der Doppeleiche 3-5
04103-7393

Cromemco
i n c o r p o r a t e d
Specialists in computers and peripherals
280 BERNARDO AVE., MOUNTAIN VIEW, CA • (415) 964-7400

Circle 80 on inquiry card.

In the Queue

Foreground

Background

Nucleus

BYTE is published monthly by BYTE Publications Inc, 70 Main St, Peterborough NH 03458. Address all mail except subscriptions to above address: phone (603) 924-7217. Address all editorial correspondence to the editor at the above address. Unacceptable manuscripts will be returned if accompanied by sufficient first class postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE. Address all subscriptions, change of address, Form 3579, and fulfillment complaints to BYTE Subscriptions, PO Box 590, Martinsville NJ 08836. Second class postage paid at Peterborough NH 03458 and at additional mailing offices—USPS Publication No. 102410. Canadian second class registration No. 9321. Subscriptions are $15 for one year, $27 for two years, and $39 for three years in the USA and its possessions. In Canada and Mexico, $17.50 for one year, $32 for two years, and $46.50 for three years. $25 for a one year subscription by surface mail worldwide. Air delivery to selected areas at additional rates available upon request. $25 for a one year subscription by air delivery to Europe. Single copy price is $2.00 in the USA and its possessions, $2.40 in Canada and Mexico, $3.50 in Europe, and $4.00 elsewhere. Foreign subscriptions and sales should be remitted in United States funds. Printed in United States of America. Each separate contribution to this issue and the issue as a collective work copyright © 1978 by BYTE Publication Inc. All rights reserved.

Subscription WATS Line: (800) 258-5485

BYTE July 1978
Volume 3 Number 7

This month's cover shows Babbage's 1822 difference engine, a device designed to calculate values in mathematical tables. Charles Babbage was one of the earlier pioneers in the field of computational machinery, whose work paved the way for later breakthroughs in computing.

In This BYTE

One way to demonstrate your KIM-1 computer is to use it as a clock. Robert Baker's article **KIMER: A KIM-1 Timer** shows you how to display hours, minutes and seconds on the computer's LED display. The program can also be used as a timer.
page 12

Heat sensitive aluminized paper is the key ingredient in Axiom's unusual EX800 printer. Find out about one user's reactions to this peripheral in **The Axiom EX800 Printer: A User's Report** by R J Bosen. *page 28*

Transforming the goal "I want thus and so function" into a program which performs that function is an act of design. Albert D Hearn provides the novice programmer with some background philosophy about design of personalized programs in his article entitled **Modular Programming**.
page 32

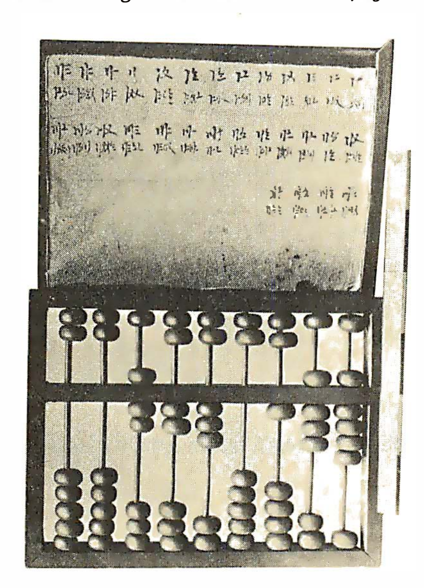
Are *you* afraid of dynamic memories? Let author Lane T Hauck remove some of the mysteries about these devices in **Who's Afraid Of Dynamic Memories?** The greatest potential of the dynamic memory for the experimenter is its low price; reading the article should prove to be a "refreshing" experience. *page 42*

Dr James M Williams takes readers on a fascinating tour of early experiments in automata in his article **Antique Mechanical Computers, Part 1: Early Automata**. Read about Vaucanson's mechanical duck and the other miraculous pre-19th century devices that foreshadowed today's computers. *page 48*

Today more and more design engineers are introducing parallel processing into computer systems to improve throughput rates. With the advent of inexpensive microprocessors, experimenters can now investigate this fascinating area. Find out more by reading Robert Loewer's **The Z-80 in Parallel**. *page 60*

When did personal computing really begin? Was it 1974 or 1971? The surprising answer is 1966. Sol Libes' **The First Ten Years of Amateur Computing** traces the growth of this rapidly growing field over the past decade, and gives credit to the true pioneers.
page 64

The ability to control DC motors allows you to imagine applications from games to robotics. Robert L Walton describes a simple method of shaft position control in his article, **Controlling DC Motors**. *page 72*



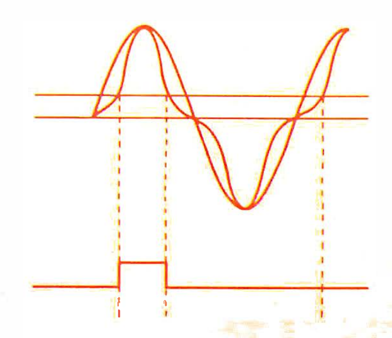
Have you ever wondered how this business of computing ever got started? And just what were the major developments and discoveries that made the computer industry what it is today? Well, take **A Short History of Computing** course by reading the article by Keith S Reid-Green. It provides a perspective on the antecedents of today's developments in the field of computing. *page 84*

If you would like to turn your printer or other peripheral on and off from your computer keyboard, Steve Ciarcia describes a simple way to do it with an EROM in **Ciarcia's Circuit Cellar: Build a Keyboard Function Decoder**. *page 98*

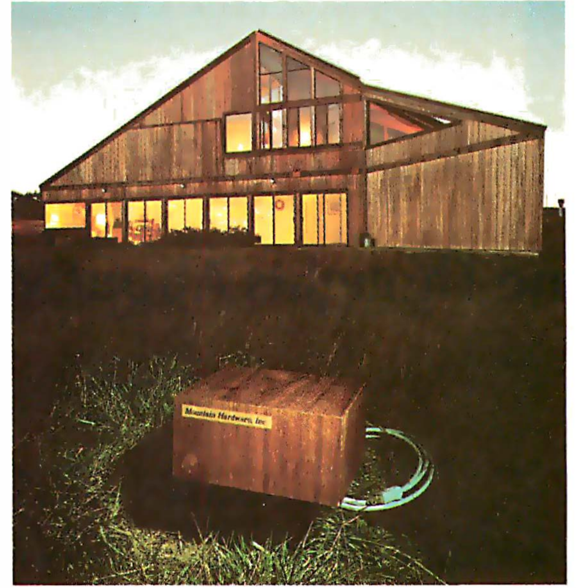
How do I choose a microprocessor for personal computing? In some respects the problem is analogous to attempting to choose between a V-8 and a V-6 automobile engine of the same horsepower: both make the car go and most users couldn't care less about the type of engine so long as the car gets them to their desired destinations. Similar considerations apply in the choice of a personal computer product based on the microprocessor it contains. Who cares what microprocessor the product contains, so long as it accomplishes a certain minimum level of function with respect to systems and applications software? Lou Frenzel of the Heath Company gives some thoughts on **How to Choose a Microprocessor** in an article in this issue. *page 124*

Thinking of writing your own high level language interpreter for your home computer? If so, Ted Williams' and Steve Conley's article, **A High Level Language for 8 Bit Machines**, will supply you with an overview of one such implementation. The language that they develop is suitable for use as both an interpreter or a compiler. *page 152*

If you own a Tarbell cassette interface, read **How to Get Your Tarbell Going**. Author Larry Weinstein explains how the unit works and gives some suggestions for improving performance. *page 162*



The Ultimate Turn-on



On/off control everywhere– by computer over the AC wiring

Now it's simple and economical to control AC devices remotely from an S-100 or Apple II computer. Mountain Hardware's new Introl™ system delivers on/off commands over the existing AC lines — so you don't have to string a foot of wire!

Control at any AC outlet. The Introl system impresses a code-modulated 50 KHz control signal on the house wiring. Then decodes the signal at any outlet to switch AC devices on and off. You can control lights, refrigerators, TVs, solenoid valves, sprinklers, burglar alarms — and many other things we leave to your fertile imagination. With the addition of input sensors to your computer system, you can automatically control variables such as temperature and soil moisture.

Here's how it works. You plug in a single AC Controller board at the computer bus and connect the AC Interface Adapter to any convenient 115 VAC outlet. The AC Controller is now connected to address as many as 64 channels remotely. But it's completely isolated from the 115v power, so there's no chance of short or shock.

At any outlet where you seek control, plug in a Dual Channel AC Remote. Then plug one or two devices to be controlled into the box. Every AC remote has two independent 500 watt channels. When commanded by the computer, the Dual Channel AC Remote turns the devices on and off independently. When polled by the computer, the Dual Channel AC Remote sends a signal back, telling the computer the status of each device. Bidirectional communication provides error free operation.

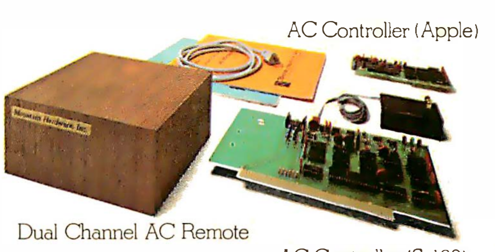
Simple programming. You write your control program in BASIC or Assembler language. Software subroutines for the control programs come with the equipment — along with complete documentation. With your computer, you can program on/off commands at any day and time using our optional Clock boards for S-100 or Apple II computers. A self contained power source assures fail safe operation.

Modest prices. The Introl Remote Control System consists of one AC Controller, either S-100 or Apple II, and one Dual Channel AC Remote. It costs $329 completely assembled and tested. Additional Dual Channel AC Remotes are $99.

The 100,000 Day Clock for S-100's costs $219 assembled and tested. The Apple Clock costs $179 assembled and tested.

All prices are f.o.b. Scotts Valley, CA. Prices are USA Domestic. California residents add 6% sales tax.

Where to find it. The Introl System can now be found at computer shops throughout the U.S. and Canada. Drop by and ask for a demonstration. Mountain Hardware, Inc., 5523 Scotts Valley Dr., Scotts Valley, CA 95066. (408) 438-4734.



AC Controller (Apple)

Dual Channel AC Remote

AC Controller (S-100)



Editorial

Some Thoughts About Modems

By Carl Helmers

In the June 1978 issue of BYTE, on pages 103 and 104, we printed a short report on activities of Ward Christensen and Randy Suess of the Chicago Area Computer Hobbyist Exchange (or CACHE). These two gentlemen have implemented a sort of public bulletin board in the form of a computer system which answers the phone through an auto answer modem, determines the data rate of the caller's modem, generates an interactive self-documenting conversation, and is able to store messages on a floppy disk. [For those who missed the original notice, the phone number to call is (312) 528-7141. You will need a Bell 103 style modem running in originate mode at 110 or 300 bps.]

Another very active input is the continuing activity of the PCNET committee on the West Coast, which will sooner or later get around to defining a protocol appropriate to a number of users talking to each other. I also received considerable inspiration from a memo on Telemail put out by Ken Bowles of the University of California at San Diego. All these inputs add up to this present exploration of the state of modem technology as applied to the personal computer.

If you look into the technology of telecommunications, it is easy to get turned off by timesharing. After all, what reason is there to have your own computer if it is not to avoid all that accounting and bill paying on an hourly basis which is use of a timesharing account? Isn't it better to pay a lump sum and have a self-contained computer which runs without any outside ties? This view of identity between timesharing to a big computer and telecommunications in general has been a somewhat erroneous conclusion in my world view for several years.

The conclusion is easy to arrive at, since virtually all use of moderately large computers is done by timesharing telecommunications facilities. But viewpoints change when an open mind is maintained. The demonstration provided by the gentlemen of CACHE is a key input which sent me on an intellectual excursion into simple, easily implementable uses of the small computer with the phone network. The ideas which come from these thoughts are oriented towards a small integer number of people communicating with one another. These ideas are the kind which can be implemented whenever two or a few people share a common goal and live far enough away from one another to make telecommunications via their personal computers a useful practice in lieu of physical travel. The technology is present and fairly inexpensive, so there is no reason why it should not be used. And, as readers will find in the form of future articles in the magazine, the technology *is* being used. Now let's turn to two characteristic models of modems and what they can do for their owners.

Simple Communications:

Two Computers + Two People + One Phone Line + Acoustic Couplers

One of the simplest of models to implement in this sphere of computer to computer data communications is duplex transmission through the phone with similar modems at each end. For example, let us suppose that two readers are each the owner of a personal system with a spare serial port talking RS-232 levels to an acoustic modem. Further, let's suppose that they want to talk to one another using digital techniques to send words by way of the phone line. An ordinary telephone of the household variety is their link to each other via the phone network. A simple program model for conversations carried out through a typewriter style terminal keyboard with a display of mes-

Continued on page 104

Articles Policy

BYTE Publications Inc is continually seeking quality manuscripts written by individuals who are applying personal computer systems, designing such systems, or who have knowledge which will prove useful to our readers. For a more informal description of procedures and requirements, potential authors should send a self-addressed, stamped envelope to BYTE Authors' Guide, 70 Main St, Peterborough NH 03458.

Articles which are accepted are purchased with a rate of $45 per published page, based on technical quality and suitability for the intended readership. As to articles appearing in BYTE magazine, each month, the authors of the two leading articles in the reader poll (BYTE's Ongoing Monitor Box or "BOMB") are presented with bonus checks of $100 and $50. Unsolicited materials should be accompanied by full name and address, as well as return postage.■

HORIZON
THE COMPLETE COMPUTER

Look To The North Star HORIZON Computer.

HORIZON™— a complete, high-performance microprocessor system with integrated floppy disk memory. HORIZON is attractive, professionally engineered, and ideal for business, educational and personal applications.

To begin programming in extended BASIC, merely add a CRT or hard-copy terminal. HORIZON-1 includes a Z80A processor, 16K RAM, minifloppy™ disk and 12-slot S-100 motherboard with serial terminal interface — all standard equipment.

WHAT ABOUT PERFORMANCE?

The Z80A processor operates at 4MHZ — double the power of the 8080. And our 16K RAM board lets the Z80A execute *at full speed*. HORIZON can load or save a 10K byte disk program in less than 2 seconds. Each diskette can store 90K bytes.

AND SOFTWARE, TOO

HORIZON includes the North Star Disk Operating System and full extended BASIC on diskette ready at power-on. Our BASIC, now in widespread use, has everything desired in a BASIC, including sequential and random disk files, formatted output, a powerful line editor, strings, machine language CALL and more.

EXPAND YOUR HORIZON

Also available — Hardware floating point board (FPB); additional 16K memory boards with parity option. Add a second disk drive and you have HORIZON-2. Economical serial and parallel I/O ports may be installed on the motherboard. Many widely available S-100 bus peripheral boards can be added to HORIZON.

QUALITY AT THE RIGHT PRICE

HORIZON processor board, RAM, FPB and MICRO DISK SYSTEM can be bought separately for either Z80 or 8080 S-100 bus systems.

HORIZON-1 $1599 kit; $1899 assembled.
HORIZON-2 $1999 kit; $2349 assembled.

16K RAM — $399 kit; $459 assembled; Parity option $39 kit; $59 assembled. FPB $259 kit; $359 assembled. Z80 board $199 kit; $259 assembled. Prices subject to change. HORIZON offered in choice of wood or blue metal cover at no extra charge.

Write for free color catalogue or visit your local computer store.



2547 Ninth Street • Berkeley, California 94710 • (415) 549-0858

Circle 285 on inquiry card.



The answer is a

It's the serious solution to the small computer question.

Sol Systems are the key to effective, economical small computer power. Sol Systems give you the force of a powerful general purpose computer, the problem solving capability of high level languages and the operational simplicity of everyday office equipment.

From the ground up, Sol Systems were designed to do a complete job without adding a load of costly extras. In fact, when you compare the "everything included" price of a quality, field proven Sol System with anything else on the market, you'll be happily surprised to find out how little the extra performance and convenience costs.

For example, complete Sol Systems with 16,384 bytes of RAM memory start at less than $2500.* Expanded systems with 49,152 bytes of RAM memory, 1.5 million bytes of on-line disk memory, disk operating system and Extended Disk BASIC cost less than $8000.* Both systems are fully assembled, burned-in, tested and ready to go.

Sol Compatibility

Sol Systems feature the S-100 bus for pin-to-pin compatibility with a wide variety of add-on devices such as voice input and computer graphics. Standard Sol parallel and serial interfaces will drive most standard printers, modems and other peripherals.

A word about languages

No system is complete without software, and at Processor Technology we have tailored a group of high level languages, an assembler and other packages to suit the wide capabilities of our hardware.

Take a look at our exclusive Extended BASIC as an example. In cassette form, this BASIC features string and advanced

*U.S. prices only.



Sol System.

file handling, special screen commands, timed input, complete matrix, logarithmic and trigonometric functions, exponential numbers, 8 digit precision and square root. The language handles serial access files, provides tape rewind and offers cursor control for graphics capability.

The disk version has all the number crunching talents of the cassette BASIC plus instant access to data and programs on floppy disks. It includes random as well as sequential files and a unique ability to update sequential data in place.

Processor Technology FORTRAN is similar to FORTRAN IV and has a full set of extensions designed for the "stand alone" computer environment. Thousands of special application programs available through books and periodicals have already been written in this well established language.

Processor Technology PILOT is an excellent language for teachers. It is a string-oriented language designed expressly for interactive applications such as programmed instruction, drill and testing.

No wonder we call it the serious solution to the small computer question.

It's the small computer system to do the general ledger and the payroll. Solve engineering and scientific problems. Use it for word processing. Program it for computer aided instruction. Use it anywhere you want versatile computer power!

Sold and serviced only by the best dealers.

Sol Systems are sold and serviced by an outstanding group of conveniently located computer stores throughout the United States and Canada. They are also available in Australia, Europe, the United Kingdom, Central America, South America, Japan and Singapore.

For more information contact your nearest dealer listed on the following page. Or write Department B, Processor Technology Corporation, 7100 Johnson Industrial Drive, Pleasanton, CA 94566. Phone (415) 829-2600.

Circle 305 on inquiry card.

Processor Technology

Letters

DESIGNERS BEWARE: SOME 2716 CONFUSION

I just came across a very untidy situation involving read only memory numbers which may be of interest to a great number of readers. We are all familiar by now with the advantages of the 2716 erasable read only memory; however, everyone should be aware that while the Intel version (and possibly others) requires only a single +5 V supply, Texas Instruments makes a similar device with identical memory organization, number TMS2716 that requires ±5 V and +12 V supplies. This part is designed to be pin compatible with the older 2708s. Texas Instruments has another part labeled TMS2516 which is pin compatible with an Intel type 2716, requiring only a +5 V supply. While this is assuredly somewhat bizarre, there seems to be argument amongst the two companies as to who claimed the name 2716 first. It is definitely something that many will be in need to be aware of.

David Marke
Solar Dynamics Ltd
3904 Warehouse Row, Suite C
Austin TX 78704

HOW TO STAY IN CIRCULATION

I was somewhat astonished (an understatement) to find, wrapped in the splendor of the March 1978 (I think) plain brown BYTE wrapper, an April 1978 *Playboy*. Now don't get me wrong, I enjoy looking at lovely ladies; in fact it is one of my most time consuming hobbies. However, I can pick up Hef's rag anywhere in Ottawa, and right now my computer needs more tips on operating than I do. So, if you would, I'd appreciate an issue of BYTE that matches the enclosed mailing sticker. Thank you.

Kevin Szabo
Box 86, Hillcrest Dr
RR #1, Manotick
Ontario CANADA KOA 2N0

WHERE TO GET TECO

Carl Helmers' editorial in the March 1978 BYTE, page 6, was interesting to me, since the LSI-11 can run the RT11 operating system, for which there is a version of real TECO (a superset of the old PDP6/PDP10 TECO) with most or all of the features he wants, plus ability to use floppies, etc. Sources for said TECO are available from DECUS for a minimal charge. I've worked on the

Continued on page 120



Robert Baker
15 Windsor Dr
Atco NJ 08004

KIMER: A KIM-1 Timer

Listing 1: Combination digital clock and timer program written for the MOS Technology KIM-1 computer. The LED readout is used to display hours, minutes and seconds.

Address	Hexadecimal Code	Label	Op Code	Comments
00 00	00	SETHR:	#00	
01	00	SETMIN:	#00	
02	00	CNTR:	#00	
02 00	A5 00	START:	LDA SETHR	Set starting time.
02 02	85 FB		STA POINTH	
02 04	A5 01		LDA SETMIN	
02 06	85 FA		STA POINTL	
02 08	A9 00		LDA #00	
02 0A	85 F9		STA INH	
02 0C	8D 03 17		STA 1703	Set PB7 as input.
02 0F	A9 04		LDA #04	Set timer loop count.
02 11	85 02		STA CNTR	
02 13	A2 20	TIMER:	LDX #20	Timer calibration.
02 15	CA	DELAY:	DEX	
02 16	D0 FD		BNE DELAY	
02 18	A9 F1		LDA #F1	Start timer.
02 1A	8D 0F 17		STA 170F	
02 1D	20 1F 1F	WAIT:	JSR SCANDS	Display current time.
02 20	2C 07 17		BIT 1707	Wait for timer interrupt.
02 23	10 F8		BPL WAIT	
02 25	C6 02		DEC CNTR	Decrement counter.
02 27	D0 EA		BNE TIMER	Finish second timeout.
02 29	F8		SED	Set decimal mode.
02 2A	18		CLC	Clear carry.
02 2B	A0 00		LDY #00	
02 2D	A5 F9		LDA INH	Get seconds.
02 2F	69 01		ADC #01	Add 1.
02 31	85 F9		STA INH	
02 33	C9 60		CMP #60	Check if next minute.
02 35	F0 04		BEQ MIN	Branch if yes.
02 37	A2 19		LDX #19	Set delay count.
02 39	D0 23		BNE SET	Wait for next timer start.
02 3B	84 F9	MIN:	STY INH	Clear seconds.
02 3D	18		CLC	
02 3E	A5 FA		LDA POINTL	Get minutes.
02 40	69 01		ADC #01	Add 1.
02 42	85 FA		STA POINTL	
02 44	C9 60		CMP #60	Check if next hour.
02 46	F0 04		BEQ HRS	Branch if yes.
02 48	A2 14		LDX #14	Set delay count.
02 4A	D0 12		BNE SET	Wait for next timer start.
02 4C	84 FA	HRS:	STY POINTL	Clear minutes.
02 4E	A2 10		LDX #10	Set delay count.
02 50	18		CLC	
02 51	A5 FB		LDA POINTH	Get hours digits.
02 53	69 01		ADC #01	Add 1.
02 55	85 FB		STA POINTH	
02 57	C9 24		CMP #24	Check if next day.
02 59	D0 03		BNE SET	Branch if not.
02 5B	84 FB		STY POINTH	Clear hours.
02 5D	CA		DEX	Adjust delay count.
02 5E	D8	SET:	CLD	Clear decimal mode.
02 5F	A9 04		LDA #04	Reset loop count.
02 61	85 02		STA CNTR	
02 63	4C 15 02		JMP DELAY	Start next cycle.

This short program converts your KIM-1 into a 24 hour digital clock and illustrates the use of the built-in timer for long time delays, and the use of instruction loops for shorter delays. The 7 segment displays are used for output, and are used in conjunction with one of the routines in the read only memory which drives them.

To use the internal timer, IO pin PB7 of 6530-003 must be set as an input pin to allow testing of the timer interrupt. This is accomplished by setting bit 7 of the direction register (location 1703) to 0 before using the timer. The timer is started by loading it with the desired delay count, and the address used determines the timer frequency and whether or not to enable the timer interrupt. Bits 0 and 1 of the address select the timer frequency as 1, 8, 64, or 1024 μs per timer count while bit 3 enables the timer interrupt if set to 1.

This clock program uses the internal timer for a time delay of approximately 250 ms. After four time delays (1 second), the current time is incremented by 1 and the timing cycle continues. Whenever the time count is being incremented, instruction timing delays are added where needed to keep all time delays constant for whatever program route is taken. An additional instruction delay is added within the 1 second timer to calibrate the timer to exactly 1 second. If your system clock is slightly slower or faster, you may have to adjust the timer count (location 0219) for about 1 ms increments and the calibration count (location 0214) for 4 μs increments.

To set the clock, enter the desired starting time hours in location 0000 and minutes in location 0001. To start the clock, set the program starting address (0200) and depress "GO" at the desired starting time (as set in locations 0000 and 0001). If the starting time is set as 0000 (hours and minutes), the program can be used to measure elapsed times for special applications by using the "ST" button to stop the program. For even fancier applications, you can add testing of an external switch to start and stop the clock. If you would rather have a 12 hour clock, simply change the contents of location 0258 from 24 to 12.■



The Computer for the Professional

The 8813 was built with you, the professional, in mind. It quickly and easily processes cost estimates, payrolls, accounts, inventory, patient/client records and much more. You can write reports, briefs, and proposals on the 8813's typewriter keyboard, see them on the video screen, and instantly correct, revise, or print them.

Using the 8813, one person can process what would normally require many secretaries, several bookkeepers, and a great deal of *time*. And data storage takes a small fraction of the *space* used by previous methods.

You don't need to learn complicated computer languages. The 8813 understands commands in English. If you want to write your own programs, the 8813 includes a simple computer language, BASIC, that you can master in a few days. The 8813 slashes the professional's overhead. It's a powerful time and money-saving ally. Prices for complete systems including printer start at less than $8,000.

See the 8813 at your local dealer or contact PolyMorphic Systems, 460 Ward Drive, Santa Barbara, California, 93111, (805) 967-0468, for the name of the dealer nearest you.

PolyMorphic Systems

Why Apple II is the world's best selling personal computer.

Which personal computer will be most enjoyable and rewarding for you? Since we delivered our first Apple® II in April, 1977, more people have chosen our computer than all other personal computers combined. Here are the reasons Apple has become such an overwhelming favorite.

Apple is a fully tested and assembled mainframe computer. You won't need to spend weeks and months in assembly. Just take an Apple home, plug it in, hook up your color TV* and any cassette tape deck — and the fun begins.

To ensure that the fun never stops, and to keep Apple working hard, we've spent the last year expanding the Apple system. There are new peripherals, new software, and the Apple II Basic Programming Manual. And wait till you see the Apple magazine to keep owners on top of what's new.

Apple is so powerful and easy to use that you'll find dozens of applications. There are Apples in major universities, helping teach computer skills. There are Apples in the office, where they're being programmed to control inventories, chart stocks and balance the books. And there are Apples at home, where they can help manage the family budget, control your home's environment, teach arithmetic and foreign languages and, of course, enable you to create hundreds of sound and action video games.

When you buy an Apple II you're investing in the leading edge of technology. Apple was the first computer to come with BASIC in ROM, for example. And the first computer with up to 48K bytes RAM on one board, using advanced, high density 16K devices. We're working to keep Apple the most up-to-date personal computer money can buy. Apple II delivers the features you need to enjoy the real satisfaction a personal computer can bring, today and in the future.

15 colors & hi-resolution graphics, too.

Don't settle for a black and white display! Connect your Apple to a color TV and BASIC gives you instant command of three display modes: Text, 40h x 48v Color-graphics in 15 colors, and a 280h x 192v High Resolution array that lets you plot graphs and compose 3-D images. Apple gives you the added capability of combining text and graphics, too.

Back to basics, and assembly language too.

Apple speaks three languages: fast integer BASIC, floating point BASIC for scientific and financial applications, and 6502 assembly language. That's maximum programming flexibility. And, to preserve user's space, both integer BASIC and monitor are permanently stored in 8K bytes of ROM, so you have an easy-to-use, universal language instantly available. BASIC gives you graphic commands: COLOR=, VLIN, HLIN, PLOT and SCRN. And direct memory access, with PEEK, POKE and CALL commands.

Software: Ours and yours.

There's a growing selection of pre-programmed software from the Apple Software Bank — Basic Finance, Checkbook, High Resolution Graphics and more. Now there's a User Section in our bank, to make it easy for you to obtain programs developed

The Second West Coast Computer Faire



Photo 1: Some of the 14,000+ crowd amble by a young hacker programming music on a Video Brain computer.

By Chris Morgan, Editor



Photo 2: Robot trials at the Dynabyte booth, a popular attraction at the Second West Coast Computer Faire.

San Jose was the place to be last March 3, 4 and 5 for the Second West Coast Computer Faire. The Convention Center was easily able to handle the crowd of 14,169 who came to see the latest developments in personal computing.

A quick examination of some of the hundreds of manufacturers' booths revealed some trends: floppy disks are on the increase, with new models being shown or promised by Heathkit, Apple, Radio Shack and many others; more and more personal computers are now being offered with built-in floppy disks; peripherals and add-ons are



Photo 3: IBM's booth, an auspicious addition to the show.

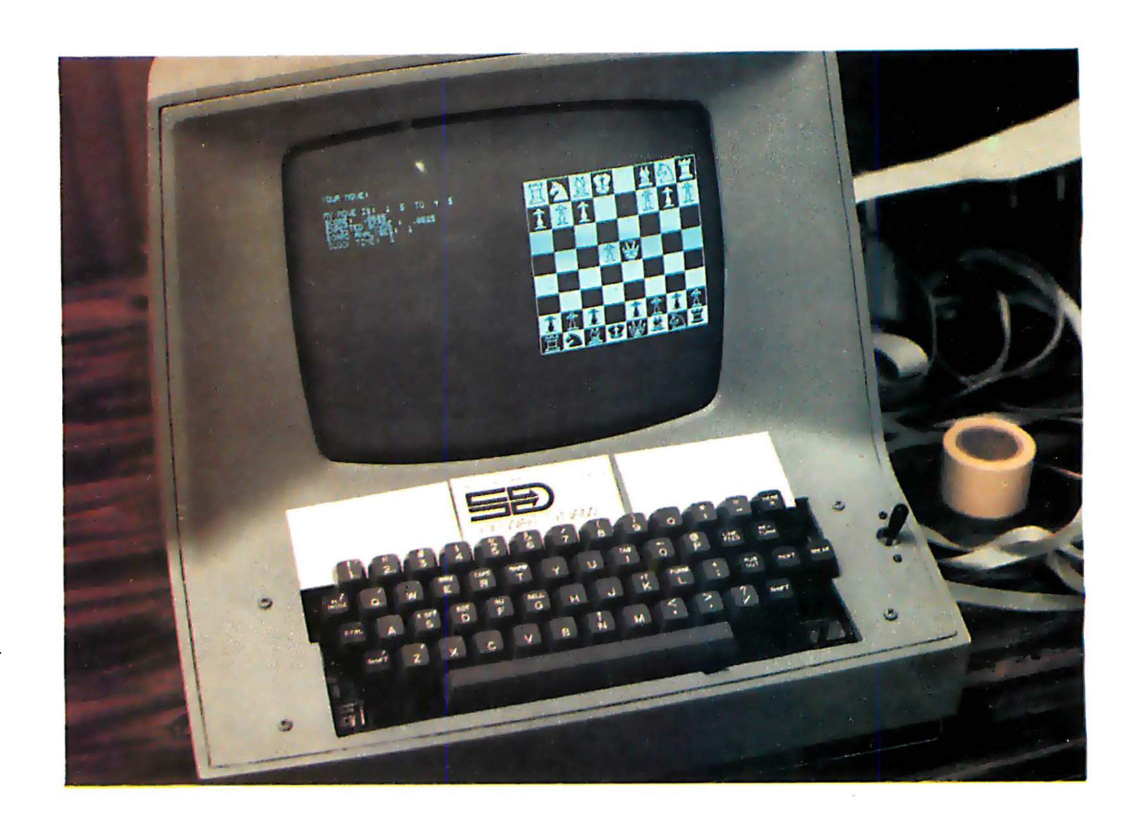
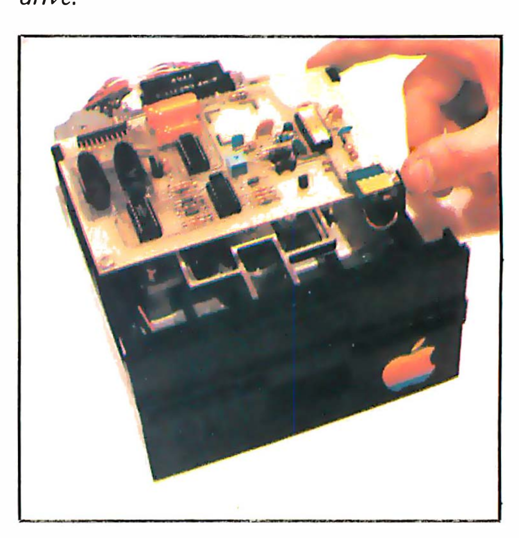


Photo 4: *Ira Baxter's chess playing system display, which competed in the Microcomputer Chess Tournament at the Faire.*



Photo 6: Objective Design's Larry Weinstein displays Star Wars graphics.

Photo 5: Apple Computer's new minifloppy drive.



now available for a wide variety of computer buses.

I enjoyed the many special features of the show, particularly the excellent computer generated art on display in the lobby. The microcomputer chess tournament proved to be one of the hits of the show. Larry Wagner from Atari presided over the 3 day battle of the processors, taking time out to give me a guided tour of the tournament. The level of play was impressive, and the winning program, called SARGON, was a 16 K byte Z-80 assembler program written by a husband and wife team, Kathe and Dan Spracklen. It beat some highly touted com-



Photo 7: Heath's new H27 dual floppy drive, scheduled to be available later this year.

petition. (A copy of the SARGON program is available for $15 postpaid from the Spracklens, 10832 Macouba Pl, San Diego CA 92124.)

I was impressed with the professional appearance of the show, which held its own with many of the established engineering and computing shows. The Third West Coast Computer Faire will be held this coming November 3, 4 and 5 in Los Angeles. Plan to see it if you can.■



Photo 8: Students from Mills College Center for Contemporary Music in Oakland demonstrate a digital and analog hybrid music synthesizer system, one of many special exhibits at the Faire.



Photo 9: Cromemco color video unit displays chess program at the Computer Room of San Jose booth.

NORTH STAR 16K RAM
A star from our Horizon

The North Star 16K RAM board is a star performer in our HORIZON computer. Just as important, it is the ideal memory for most other S-100 bus systems. No other RAM board can surpass the speed, reliability, and quality features of the North Star 16K RAM at any price.

SPEED — The North Star 16K RAM is the fastest S-100 bus memory board available. No wait states are required, even with a Z80 at 4MHz. And, of course, this outstanding 16K RAM will operate with both 8080 and Z80 processors at 2MHz. Industry standard 200ns dynamic RAM chips are used. Invisible on-board refresh circuitry allows the processor to run at full speed.

RELIABILITY — The North Star 16K RAM is designed to match the same high standards as our MICRO DISK SYSTEM and HORIZON computer. For example, all address and data signals are fully buffered. A parity check option is available with the 16K RAM for applications requiring immediate hardware error detection. If a memory error occurs, a status flip/flop is set and an interrupt can inform the processor. Or, if preferred, an error status light will go on.

FEATURES — The North Star 16K RAM offers many desirable features. Addressability is switch-selectable to start at any 8K boundary. The board can perform bank switching for special software applications, such as time-sharing. Also, bank switching can be used to expand the amount of RAM beyond 64K bytes. Power consumption is minimal — the maximum power requirements are: .6A @ 8V; .4A @ +16V, and .1A @ −16V.

PRICES — $399 kit. $459 assembled, tested and burned-in. Parity option: $39 Kit. $59 assembled, tested and burned-in.

Write for free color catalog or visit your local computer store.



2547 Ninth Street • Berkeley, California 94710 • (415) 549-0858

Circle 285 on inquiry card.

INTRODUCING THE G2™ PROGRAM LIBRARY.

Now you don't have to be a programmer to use your computer!

At last there's a reliable, professional source of useful and entertaining programs for your personal computer. The G2 Program Library from GRT unlocks the full power of your personal computer. Without any programming knowledge on your part.

The G2 Program Library consists of applications programs pre-recorded on cassette tapes. A detailed manual with each cassette provides complete instructions. And G2 programs contain prompting instructions. So they're easy to use every step of the way. Just load the tape and G2 puts your computer to work.

The first three G2 program tapes are available now: For exciting family games, get **Beat the House.** You'll find Blackjack, Craps, Roulette and Slot Machine programs, with truly random chances and realistic, casino-like payoffs.

Interested in your health? You'll want **Clinic.** Biorhythms, Dieting and Longevity programs give you new perspectives in health and happiness, along with some pleasant guidelines to follow.

Need a better handle on your money? Buy **Personal Finance.** Checkbook is a comprehensive program to balance your account and keep within your budget, while Best Choice is a novel way to make decisions based on the facts you know and the relative importance of each. Use it for everything from choosing a new car to selecting your next stereo.

Soon, every dealer that handles personal computers will stock the G2 Program Library. For the G2 dealer nearest you, call us toll-free at 800/538-1770. (In California, 800/662-9810.) And if your favorite computer outlet doesn't yet offer G2, have him call the same number.

G2 is the newest product line from GRT, the world's largest independent producer of pre-recorded tapes. We've assembled a team of software specialists to produce the G2 Program Library. The finest library of personal computer programs available.

Soon you'll see G2 program tapes in many other fields of interest. Including advanced programs to challenge the interest of even the most serious computer user. The G2 Program Library is available for most popular brands of personal computers. Just select the package marked for the computer you own.

Start building your G2 Program Library now. And put the full power of your computer to work for you. **THE REASON YOU BOUGHT YOUR COMPUTER.**







A product of GRT Corporation
Custom Products Division
1286 North Lawrence Station Road
Sunnyvale, California 94086

Circle 148 on inquiry card.

There's an Ohio Scientific dealer near you.

ALABAMA

M.C.S. Corp.
Pelham Mall
Pelham, AL 35124
(205) 663-1287

ALASKA

Scientific Business Instr's
500 W. 27th
Anchorage, AK 99503
(907) 277-2650

CALIFORNIA

Expansion Techniques
2534 Ganesha
Altadena, CA 91001
(213) 794-0476

Shuey Aircraft
1009 E. Vermont
Anaheim, CA 92805
(714) 991-3940

Olson Electronics
11332 East South
Cerritos, CA 90701
(213) 860-0060

Computer Power
1276 Via Rancho
Escondido, CA 92025
(714) 746-0064

Adventures in Computing
8756 Warner
Fountain Valley, CA 92706
(714) 848-8388

Olson Electronics
4642 West Century
Inglewood, CA 90304
(213) 674-5740

Olson Electronics
Kearny Mesa, 4840 Convoy
San Diego, CA 92111
(714) 292-1100

Systems Engineering
900 3rd Street
San Francisco, CA 94107
(415) 777-3150

Olson Electronics
2125 El Camino Real
Santa Clara, CA 95051
(408) 248-4886

COLORADO

Total Data Systems
125 Fairway Lane
Fort Collins, CO 80521
(303) 491-5692

Tricomp/Computer Country
7115 N. Federal
Westminster, CO 80030
(303) 426-7743

DELAWARE

Delaware Microsystems
92 East Main #1
Newark, DE 19711
(302) 738-3700 (after 7 PM)

FLORIDA

Olson Electronics
5833 Ponce de Leon
Coral Gables, FL 33146
(305) 666-3327

Olson Electronics
1644 N. E. Second
Miami, FL 33132
(305) 374-4121

Calculator Place
12 South Orange
Sarasota, FL 33577
(813) 366-7449

Olson Electronics
6901 22nd Avenue, N.
Tyrone Square Mall
St. Petersburg, FL 33710
(813) 345-9119

Olson Electronics
1215 South Dale Mabry
Tampa, FL 33609
(813) 253-3129

GEORGIA

Electronic Information
120 Heatherwood
Athens, GA 30601
(404) 353-2858

Secom Systems
5241-F New Peach Tree
Chamblee, GA 30341
(404) 455-0672

Olson Electronics
2571 N. Decatur
Decatur, GA 30033
(404) 378-4201

HAWAII

Small Computer Systems
3140 Wailalae
Honolulu, HI 96816
(808) 732-5246

ILLINOIS

American Microprocessors
1100 E. Broadway
Alton, IL 62002
(618) 465-4489

Tech-Tronics
714 S. University
Carbondale, IL 62901
(618) 549-8495

Adonis Computing
2855 W. Nelson
Chicago, IL 60618
(312) 463-0847

Electronic Systems
611 N. Wells
Chicago, IL 60610
(312) 944-6565

Olson Electronics
4101 N. Milwaukee
Chicago, IL 60641
(312) 545-7336

Olson Electronics
1734 Ogden
Downers Grove, IL 60515
(312) 852-9650

A & H Associates, Ltd.
2530 Crawford
Evanston, IL 60602
(312) 328-2800

No-Name
2701 Grand
Galesburg, IL 61401
(309) 343-6135

CompuTerminal Systems, Inc.
1132 Waukegan
Glenview, IL 60025
(312) 724-3690

Tek-Aids Industries
1711 Chestnut
Glenview, IL 60025
(312) 724-2620

American Microprocessors
6934 N. University
Peoria, IL 61614
(309) 692-5852

American Microprocessors
20 N. Milwaukee
Prairieview, IL 60069
(312) 634-0076

Wysocki Electric
3080 South Blvd.
Rockford, IL 61109
(815) 874-4846

Data Domain
1612 E. Algonquin
Schaumburg, IL 60195
(312) 397-8700

INDIANA

American Microprocessors
146 N. Broad
Griffith, IN 46319
(219) 924-7901

American Microprocessors
3602 East Washington
Indianapolis, IN 46201
(317) 359-7445

American Microprocessors
2655 Irving
Portage, IN 46368
(219) 760-2278

Computer Management
610 Monroe
LaPorte, IN 46350
(219) 362-5812

Data Domain
406 S. College
Bloomington, IN 46401
(812) 334-3607

Data Domain
7027 N. Michigan
Indianapolis, IN 46268
(317) 251-3139

Data Domain
10 N. Third
LaFayette, IN 47902
(317) 423-2548

Olson Electronics
5353 N. Keystone
Indianapolis, IN 46220
(317) 253-1584

IOWA

American Microprocessors
102 E. 4th
Waterloo, IA 50703
(319) 296-2255

John E. Childs
1201 E. Second
Ohumwa, IA 52501
(515) 682-2165

Microbus
1910 Mt. Vernon, S. E.
Cedar Rapids, IA 52403
(319) 364-5075

KANSAS

Barney & Associates
425 N. Broadway
Pittsburg, KS 66762
(316) 231-1970

Technigraphics
5911 Claredon
Wichita, KA 67220
(316) 744-2443

KENTUCKY

Data Domain
3028 Hunsinger
Louisville, KY 40220
(502) 456-5242

Olson Electronics
117 Southland
Lexington, KY 40503
(606) 278-9413

Olson Electronics
4137 Shelbyville
Louisville, KY 40207
(502) 893-2562

MARYLAND

Systems Engineering
1749 Rockville Pike #307
Rockville, MD 20842
(301) 468-1822

The Mathbox
4431 Lehigh
College Park, MD 20740
(301) 277-6828

MASSACHUSETTS

Bradshaw Enterprises
18 Harborview
Hingham, MA 02043
(617) 749-6844

Computer Shop-Aircom
288 Norfolk
Cambridge, MA 02139
(617) 661-2670

MICHIGAN

The Abacus
Route 1, Box 193
Niles Road
Berrien Springs, MI 49103
(616) 429-3034

Concept Engineering
3706 Malibu
Lansing, MI 48910
(517) 394-0505

Great Lakes Photo
5001 Eastman
Midland, MI 48640
(517) 631-5461

MicroComputer World
313 Michigan N. E.
Grand Rapids, MI 49503
(616) 451-8972

Olson Electronics
29121 DeQuindre
Madison Heights, MI 48071
(313) 546-0190

MINNESOTA

Custom Computer Systems
1823 Lowry
Minneapolis, MN 55411
(612) 588-3944

Micro Business Sales
4345 Lyndale N.
Minneapolis, MN 55412
(612) 871-9230

MISSISSIPPI

Jack Fisher Sales
100 Main
Michigan City, MS 38647
(601) 224-6470

MISSOURI

The Computer Bit
1320 S. Glenstone
Springfield, MO 65804
(417) 883-2709

Computer Place
Rt. #4, Box 91-D
Joplin, MO 64801
(417) 781-1986

Futureworld
1909 Seven Pines
St. Louis, MO 63141
(314) 434-1121

Impact Systems
Decker Building
613 W. 3rd
P.O. Box 478
Lee's Summit, MO 66463
(816) 524-5919

Norman Electronics
402 Wall
Joplin, MO 74801
(417) 724-0368

MONTANA

Linco
P.O. Box 2418
Cut Bank, MT 59427
(406) 336-3117

NEBRASKA

Omaha Computer Store
4540 South 84th
Omaha, NB 68127
(402) 592-3590

NEW JERSEY

Computer Corner
224 Passaic
Fairfield, NJ 07006
(201) 835-7080

Computer Power
235 Nutley
Nutley, NJ 07110
(201) 667-5502

NEW YORK

Associated Consultants
33 Ogden
East Williston, NY 11596
(516) 746-1079

Brag Microcomputers
19 Cambridge
Rochester, NY 14607
(716) 442-5861

Computer Mart of N. Y.
118 Madison
New York, NY 10016
(212) 686-7923

Microcomputer Workshop
234 Tennyson Terrace
Williamsville, NY 14221
(716) 632-8270

Yingco
Two World Trade Center
Penthouse 107th Floor
New York, NY 10048
(212) 775-9000

OHIO

Byte Shop
2432 Chester
Columbus, OH 43221
(614) 486-7761

Johnson Computer
123 W. Washington
Medina, OH 44256
(216) 725-4560

Lucas Office Equipment
& Service
869 E. Franklin
Centerville, OH 45459
(513) 433-8484

Olson Electronics
69 West State
Akron, OH 44308
(216) 762-0301

Olson Electronics
1994 Brittain
Akron, OH 44310
(216) 633-4338

Olson Electronics
3265 W. Market
Akron, OH 44313
(216) 864-3407

Olson Electronics
2020 Euclid
Cleveland, OH 44115
(216) 621-6387

Olson Electronics
6813 Pearl
Cleveland, OH 44130
(216) 845-2424

Olson Electronics
6153 Mayfield
Cleveland, OH 44124
(216) 449-2690

Olson Electronics
21850 Center Ridge
Cleveland, OH 44116
(216) 331-4600

Olson Electronics
1975 Henderson
Columbus, OH 43220
(614) 451-3245

Olson Electronics
7401 Market
Southern Park Mall
Youngstown, OH 44512
(216) 758-3828

OKLAHOMA

Accounting Systems
2709 Orlando
Oklahoma City, OK 73120
(405) 751-1537

Gauger Engineering
910 Orient
Clinton, OK 73601

Gauger Engineering
3824 S. 79th East
Tulsa, OK 74145
(918) 627-1064

OREGON

Fial Computer
11013 S. E. 52nd
Milwaukie, OR 97222
(503) 654-9574

PENNSYLVANIA

Abacus Data Systems
Route 8
Reno, PA 16343
(814) 677-6502

Olson Electronics
5918 Penn
Pittsburgh, PA 15206
(412) 362-1333

Olson Electronics
3405 Saw Mill Run
Pittsburgh, PA 15227
(412) 881-0702

Olson Electronics
4778 McKnight
Pittsburgh, PA 15237
(412) 366-7298

TENNESSEE

Computer Power of Memphis
3065 James
Memphis, TN 38128
(901) 386-9905

Computer Power of Oak Ridge
800 Oak Ridge Turnpike
Oak Ridge, TN 38730
(615) 482-9031

Smart Machine Mart
5151 Hillson
Nashville, TN 37211
(615) 833-9773

SOUTH DAKOTA

Exe Engineering
804 E. Lewis
Vermillion, SD 57069
(605) 624-6411

TEXAS

Mr. Computer
744 FM 1960 W., Suite E
Houston, TX 77090
(713) 444-7419

UTAH

Small Computer Systems
4450 Trinity
Salt Lake City, UT 84120
(801) 967-7635

VIRGINIA

H/B Computers
217 E. Main
Charlottesville, VA 22101
(804) 295-1975

Microsystems, Inc.
5320 Williamson
Roanoke, VA 24012
(703) 563-0693

WASHINGTON

Ye Olde Computer Shoppe
1301 George Washington
Richland, WA 99352
(509) 946-3330

WISCONSIN

Madison Computer Store
1863 Monroe
Madison, WI 53711
(608) 255-5552

MicroComp
785 S. Main
Fond du Lac, WI 54935
(414) 922-2515

Olson Electronics
3125 South 108th
West Allis, WI 53227
(414) 541-1406

WYOMING

Control Technology
204 Crazy Horse Lane
Gillette, WY 82716
(307) 682-0300

CANADA

Omega Computing Ltd.
Box 220
Station P
Toronto, Ontario
Canada M5S 2F7
(416) 425-9200

Robo-Tronics
509 16th N. W.
Calgary, Alberta
Canada T2M 0J6
(403) 282-9468

EUROPE

Pan Atlantic Computer
System GmbH
61 Armstadt
Frankfurterstrasse 78
West Germany

Circle 290 on inquiry card.



If you are interested in an ultra high performance personal computer which can be fully expanded to a mainframe class microcomputer system, consider the C2-8P.

Features:

- Minimally equipped with 8K BASIC-in-ROM, 4K RAM, machine code monitor, video display interface, cassette interface and keyboard with upper and lower case characters. (Video monitor and cassette recorder optional extras.)
- The fastest full feature BASIC in the microcomputer industry.
- Boasts the most sophisticated video display in personal computing with 32 rows by 64 columns of upper case, lower case, graphics and gaming elements for an effective screen resolution of 256 by 512 elements.
- The CPU's direct screen access, coupled with its ultra fast BASIC and high resolution, makes the C2-8P capable of spectacular video animation directly in BASIC.
- Fully assembled and tested: 8 slot mainframe class microcomputer, six open slots for expansion. Supports Ohio Scientific's ultra low cost dynamic RAM boards or ultra high reliability static RAMs.
- The C2-8P can support more in-case expansion than its four nearest competitors combined.
- The C2-8P is the only BASIC-in-ROM computer that can be directly expanded today to a complete business system with line printer and 8" floppy disk drives.
- It is the only personal class computer that can be expanded to support a Hard Disk! (CD-74)

The C2-8P is the fastest in BASIC, has the most sophisticated video display and is the most internally expandable personal computer. Therefore, it should be the highest priced?

Wrong: The C2-8P is priced considerably below several models advertised in this magazine. The C2-8P is just one of several models of personal computers by Ohio Scientific, the company that first offered full feature BASIC-in-ROM personal computers.

For more information, contact your local Ohio Scientific dealer or the factory at (216) 562-3101.

OHIO SCIENTIFIC

1333 S. Chillicothe Road • Aurora, Ohio 44202



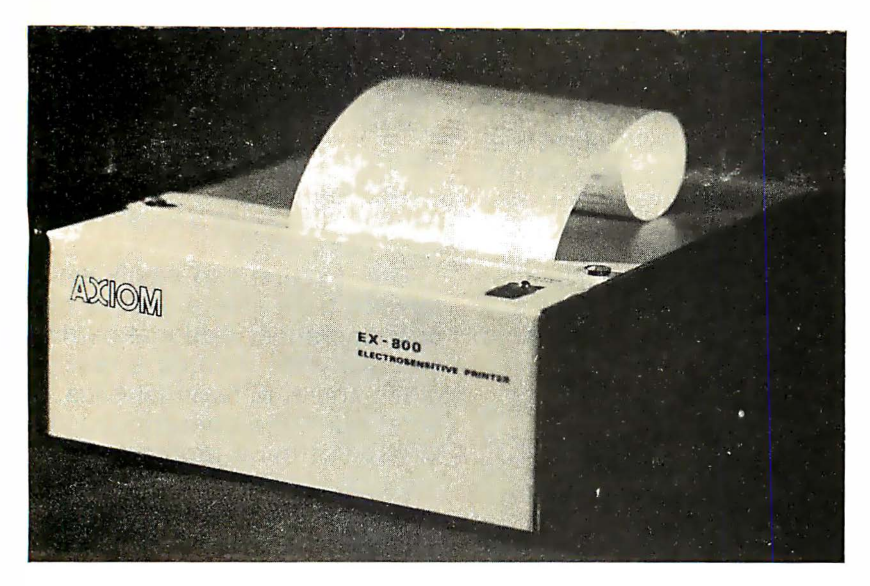


Photo 1: The Axiom EX800 printer. It uses special aluminized paper; when a tiny electrical spark jumps from the print head to the paper, the layer of aluminum is burned off revealing the next layer which is darkly colored. Printing speed is a maximum of 160 characters per second including upper and lower case letters. The printer allows 80 column page width and quadruple width characters.

The Axiom EX800 Printer: A User's Report

R J Bosen
POB 93
Magna UT 84044

Some time ago I decided I needed a hard copy printer to make my computer system really useful, but as I looked over the possibilities on the market I concluded that every alternative was either too expensive, too slow, or too limited in capability for my needs (which included good legibility and lower case printing).

Just as I was about to abandon my plans, I saw a press release concerning a company called "Axiom" and a printer that appeared to solve all of my problems. It was advertised at $660, could print up to 160 characters per second (including upper and lower case letters) with an 80 column page width, and offered double and quadruple width characters as a bonus. I immediately wrote to Axiom and was surprised to receive a thick information packet within a week.

My first (and only) disappointment came as I discovered that the 80 column page width was squeezed onto a 5 inch roll of special paper which was a little hard to read, but other features of the printer looked promising enough to justify further investigation, so I experimented with the printout sample they sent me to see if I could find ways around these annoyances. I went to a photocopy center and found it was quite easy to get very sharp copies which were much more readable than the original. I decided that if the narrow page width became a serious problem I could write software to split a wide page into two 5 inch columns and print a page in two passes. Experimenting with the photocopier confirmed the feasibility of this idea as I successfullly laid two 5 inch pieces of the sample printout side by side and obtained the illusion of a 9 inch page width.

I phoned the desk at Axiom to place my order; ten days later the printer was in my hands. I opened it up to reveal an Intel 4004 processor controlling an electrosensitive printing mechanism that works with special paper, consisting of a layer of paper, a layer of ink, and an aluminum upper layer. The print head strokes across the paper and burns the aluminum off in tiny dots, exposing the ink underneath in patterns stored in the processor read only memory. The processor controls character size and line length, allowing very flexible mixing of character sizes anywhere on any line and giving automatic line feeds when the end of the line has been reached. Other benefits of the

```
PRINTOUT SAMPLE
from the AXIOM EX-800

ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz1234567890!"#$%&'()*=-+()
ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmn
ABCDEFGHIJKLMNOPQRST
abcdefghijklmnopqrst
```

Figure 1: A sample printout of the Axiom EX800 printer. This sample was made by photographically reproducing the original silver colored paper image at a 1:1 scale.

microprocessor control include a self-test feature activated by pushing a button on the back panel which prints a test pattern on the paper, and a convenient parallel interface with simple handshaking. A serial interface is optional.

I found the documentation very complete and readable and had no trouble interfacing with my parallel data port and writing driver software in a couple of dozen bytes. Trying it out on line proved to be a rewarding experience; my interface and driver software worked the first time. I was finally able to try out the many ideas I had been considering while waiting for shipment. I noticed the effect of the 128 character buffer that Axiom provided: short printouts require almost no processor time, as the parallel interface transfers data from the processor memory to the printer buffer very fast and the processor is immediately freed to do other jobs. I was pleased with the quietness. It is not as loud as a Teletype even though it is about 14 times faster. It didn't take me long to discover the buzzer that can be activated by a special character, and I have learned to use it for special effects in game programs even when the printer is not needed.

The only problems I have ever had with this printer have been concerned in one way or another with the paper. This is not to imply that I have had a lot of problems. I haven't. But finding a supplier for paper was a problem for me in Salt Lake City. I called every paper supplier in the phone book and I couldn't get anyone to even recognize the existence of "electrosensitive" paper. Fortunately, within a few weeks I found myself in DePere WI repairing a computer system for my employer, and while there I took a tour of the Nicollet Paper Company, where the electrosensitive paper is made. They sold me a case of 24 rolls of the special paper at about $3 a roll and let me look at some of the experimental paper they are developing for use by electrosensitive printers. This new paper is much whiter than the silver grey originally shipped to me and I am anxious to see it introduced in production quantities.

I am very pleased with the Axiom EX800 printer, and I recommend it to anyone who needs a printer of this nature. Incidentally, Axiom also has a similar printer with a graphics capability that may be of interest to experimenters. You can obtain more information by writing to Axiom Corporation, 425 E Green St, Pasadena CA 91101.■

COOK BOOK • ASSEMBLER • EDITOR
MONITOR • POCKET GUIDE • TAPES
UNDERSTANDING MICROCOMPUTERS
COOK BOOK • ASSEMBLER • EDITOR
MONITOR • POCKET GUIDE • TAPES
UNDERSTANDING MICROCOMPUTERS



Scelbi's Software Gourmet Guides and Cookbooks for '8080' or '6800'.

Now you can cook up mouth-watering programs. Delectable "how to" facts include '8080' or '6800' instruction sets. How to manipulate stacks. Flow charts. Source listings. General purpose routines for multiple precision operation. Programming time delays for real time. And much, much more. Includes floating point arithmetic routines. Order your copies today! Specify '8080' or '6800'.
'8080' Paperback: **$10.95;** Vinyl: **$12.95;** Hardcover: **$14.95.**
'6800' (Paperback only): **$10.95.**

Order your SCELBI Personal Computer Books and Tapes today! They are "must" items for your collection. And, they make ideal special occasion gifts for that computer buddy too!

SCELBI COMPUTER CONSULTING INC.

Post Office Box 133 PP STN, Department B, Milford, CT 06460

Prices shown for North American customers. Master Charge, VISA, Postal and Bank Money Orders preferred. Personal checks delay shipping up to 4 weeks. Pricing, specifications, availability subject to change without notice. **IMPORTANT!** Include 75¢ postage/handling for each item delivered by U.S. Mail Book Rate; or $2 for each item shipped First Class or UPS.

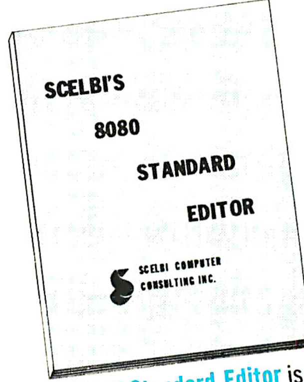
Scelbi Software

Outstanding books for the personal computer user. Recognized, authoritative texts and tapes that add new dimensions of fun and skill to your computer.

SCELBI'S 8080 STANDARD ASSEMBLER

SCELBI COMPUTER CONSULTING INC.

Scelbi's '8080' Standard Assembler assembles programs written in symbolic language for '8080'. Describes operation of assembler. Detailed discussions of all major routines. Contains 2 completely assembled listings — hexadecimal and octal. Operating instructions. Even includes routine for loading programs produced by the assembler. All memory references are labeled; can reassemble to reside in ROM. (Some RAM required) **$19.95.** Optional object code on punched paper tape, specify 8080SA-OPT: **$10.00.** Optional commented source listing on punched paper tape, specify 8080SA-SPT: **$39.00.**



Scelbi's '8080' Standard Editor is an efficient way to edit text when preparing program source listings or other text material. Operates in 2 modes: Text Entry and Command. Memory references labeled for easy reassembly into any general area of memory; e.g. reassemble to reside in just 1K of ROM. (Some RAM required) **$12.95.** Optional object code on punched paper tape, specify 8080ED-OPT: **$6.00.** Optional commented source listing on paper tape too. Specify 8080ED-SPT, **$20.00.**



Scelbi's '8080' Standard Monitor. Describes "Monitor Control" package to control operation from external "keyboard". Routines to examine and modify memory locations, CPU registers, continuous 2-point "bug" status report, control bulk storage, I/O devices. And more. **$9.95.** Optional object code on punched paper tape, specify 8080SM-OPT: **$5.00.** Optional commented source listing on punched paper tape, specify 8080SM-SPT: **$15.00.**



Understanding Microcomputers and Small Computer Systems. A profusely illustrated, easy-reading "must" book explaining fundamental concepts behind operation of microcomputers in simple English. Gives extra knowledge for reading and understanding computer magazines and manufacturers' literature. Makes you feel "at home" around computers. Accepted as the standard for the neophyte, you must own this 300-page no-nonsense, easy-reading text. Includes simple-to-use glossary of key microcomputer-oriented words. Order now. Hard cover: **$14.95.** Soft cover: **$9.95.**



The '8080' Programmer's Pocket Guide A compact 3 x 4½", ever-ready, instant reference for octal or hexadecimal codes, that explains instruction set in detail. Order your copy today. Keep one in your pocket. One near your computer. A "must"! **Only $2.95 each.**

ADVANCE NOTICE!!!

Watch for the all new Scelbi's First Book of BASIC Programs! Coming soon!

Want to be on Scelbi's exclusive mailing list? Want to know about upcoming Scelbi Books? Don't use the "BINGO" Card — but write us DIRECTLY. It identifies you as a "truly interested" customer who is worthy of special handling!

Circle 310 on inquiry card.

Top-Down Modular Programming

Albert D Hearn
98 SW 13th Av
Boca Raton FL 33432

If you have done some programming, you know that it's one of the most enjoyable and satisfying parts of personal computer use. The very thought that the vast power in the small system's processor is limited only by the program that you write for it is tremendously exciting.

If you are new to the computer game, the programs you have written up to now have probably been relatively small and uncomplicated, but you have developed a lot of experience and confidence from them. Most likely you haven't used any particular technique in designing and writing your programs: you have probably approached program design in an informal way and relied upon your good senses to guide you in this unfamiliar task. You have probably also gained an understanding of the full capabilities of the instruction set and some of the little tricks (yes, ADDing a binary number to itself really does result in a left shift of one bit) which can be so useful. You are also capable of writing IO routines to do about any kind of data transfer you want.

So now you are ready to do a program which does something really useful. The program you have in mind is going to be larger and more complicated than those you have done previously. While you might not expect this, your previous informal methods of designing and coding might possibly be inadequate and could cause you much grief if you attempt to use them on a larger program.

Hopefully, I can help you prevent these kinds of difficulties by showing you in this article an easy to use method of designing and structuring larger programs which can greatly simplify your personal efforts, regardless of complexity.

The Concept

Someone once said, "To solve a complex problem, simply break it down into a number of less complex pieces, then proceed to solve it one piece at a time." This approach has been used for many years in the design and building of electronic equipment. It results in a "building block," or "modular" construction, where each block or module does some distinct part of the total function of the equipment. For instance, think of the last time you saw a diagram of a radio receiver. It was probably in the form of a set of separate blocks representing the RF amplifier, mixer, IF amplifier, and so on. The blocks were all connected with flow lines showing the sequence in which each equipment module processed a signal coming from the antenna. The diagram enabled the reader to understand the function of the radio one module at a time, in relation to the whole radio.

So how does the idea of using building blocks and solving problems piecemeal relate to the programming of personal computers? The answer is that these same ideas are very applicable to programming and have been in use in commercial programming for a number of years. There is no reason that good use of them can't be made in the amateur computer hobby also.

Top-down Design

Top-down design of microprocessor programs requires that you first have a clear notion about what it is that you want the program to do. You should ask yourself questions like, "What function do I want performed?", "What input information is available?", and "What output information or action do I expect?" When you can answer these questions, you've actually completed the highest level of design.

BUYING HARDWARE

Pros

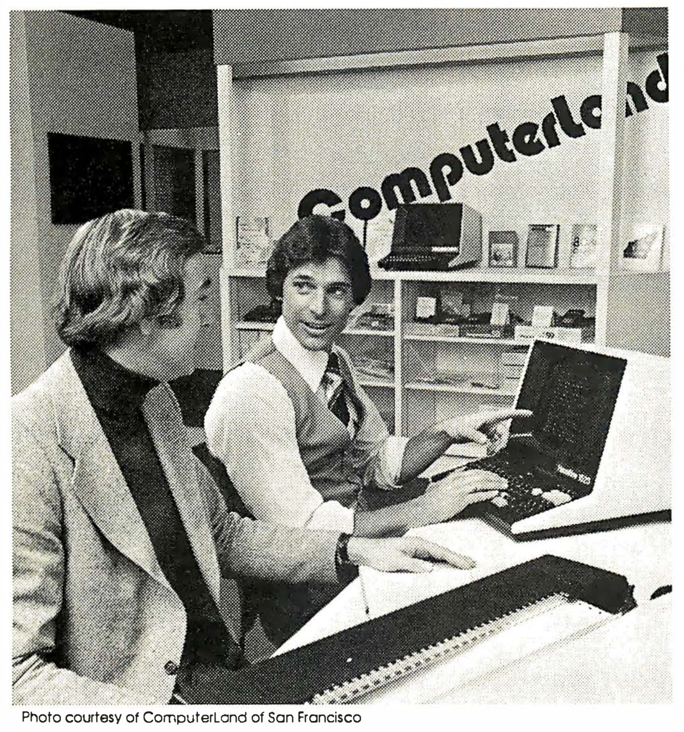


Photo courtesy of ComputerLand of San Francisco

Cons



Computerland, the DP Department Store. Hazeltine & Diablo on Display.

Time was, buying hardware meant dealing factory direct. Then came the distributor, or factory indirect. The phone/mail order ad reads, "15% off." 15% off what? Delivery schedule maybe. After sales service perhaps. The only real savings just might be the Toll Free number in the ad.

Now there's an alternative. Introducing ComputerLand, a national network of DP equipment stores, with outlets across the nation. This means you, and the DP director, programmer, general manager or purchasing agent can take a quick ride across town, try out working equipment in a user environment, make product comparisons, then drive off with the hardware of your choice. And, still be back in time for the afternoon coffee break.

Below is a sampling of the quality business information products, from more than 60 manufacturers of micro and mini-computer systems and peripherals, available for you to try out, buy or lease and take home today from ComputerLand.



HAZELTINE 1500

☐ 24 X 80 Display (upper/lower case) ☐ High legibility 7 X 10 dot matrix ☐ Teletypewriter format for alphanumerics plus numeric pad ☐ Switch-selectable upper/lower case ☐ R S -232/C 20 ma.current loop interface ☐ Switch-reversible video.



DIABLO 1620-3

☐ HyType daisy wheel character printer ☐ Full keyboard with numeric pad ☐ Microprocessor controlled ☐ R S -232/C interface ☐ 45 CPS ☐ Tractor feed ☐ Internal power supply.

ComputerLand™

14400 Catalina Street, San Leandro, CA 94577 (415) 895-9363

Franchise opportunities available.

ALABAMA

3020 University Or., N.W.
Huntsville 205-539-1200

CALIFORNIA

6743 Dublin Blvd.
Dublin 415-828-8090

11074 San Pablo Avenue
El Cerrito 415-233-5010

22634 Foothill Blvd
Hayward 415-538-8080

4546 El Camino Real
Los Altos 415-941-8154

6840 La Ciegega Blvd.
Inglewood 213-776-8080

24001 Via Fabricante #904
Mission Viejo 714-770-0131

289 East Highland Avenue
San Bernardino 714-886-6838

4233 Convoy Street
San Diego 714-560-9912

117 Fremont Street
San Francisco 415-546-1592

1077 Saratoga-Sunnyvale Road
San Jose 408-253-8080

42 - 42nd Avenue
San Mateo 415-572-8080

611 - 5th Street
Santa Rosa 707-528-1775

16720 So. Hawthorne Blvd.
Lawndale 213-371-7144

El Cid Plaza - Suite 104
Thousand Oaks 805-495-3554

104 W. First Street
Tustin 714-544-0542

1815 Ygnacio Valley Road
Walnut Creek 415-935-6502

6840 La Cienoga Blvd.
Inglewood 213-776-8080

COLORADO

2422 So. Colorado Blvd.
Denver 303 759-4685

CONNECTICUT

2475 Black Rock Turnpike
Fairfield 203-374-2227

DELAWARE

Astro Shopping Center
Newark 302-738-9556

GEORGIA

2423 Cobb Parkway
Smyrna 404-953-0406

ILLINOIS

50 East Rand Road
Arlington Heights 312-255-6488

9511 No. Milwaukee Avenue
Niles 312-967-1714

10935 S. Cicero Avenue
Oak Lawn 312-422-8080

KENTUCKY

813 B. Lyndon Lane
Louisville 502-425-8308

MARYLAND

16065 Frederick Road, (Rt. 355)
Rockville 301-948-7676

MICHIGAN

2927 - 28th Street, S. E.
Kentwood 616-942-2931

29673 Northwestern Highway
Southfield 313-356-8111

MINNESOTA

8070 Morgan Circle Drive
Bloomington 612-884-1474

NEW HAMPSHIRE

419 Amherst
Nashua 603-889-5238

NEW JERSEY

1442 E. Route 70
Cherry Hill 609-795-5900

2 De Hart Street
Morristown 201-539-4077

NEW YORK

1612 Niagara Falls Blvd.
Buffalo 716-836-6511

225 Elmira Road
Ithaca 607-277-4888

OHIO

1288 SOM Center Road
Mayfield Heights 216-461-1200

OREGON

12020 S. W. Main Street
Tigard 503-620-6170

TEXAS

3300 Anderson Lana
Austin 512-452-5701

6439 Westheimar
Houston 713-977-0909

WASHINGTON

14340 N. E. 20th
Bellevue 206-746-2070

1500 South 336th Street
Parkway Center, Suite 12
Federal Way 206-838-9363

8791 So. Tacoma Way
Tacoma 206-581-0388

WISCONSIN

690 S. Whitney Way
Madison (Directory Assistance)

INTERNATIONAL

52-58 Clarence Street
Sydney NSW 2000
Australia TLX: AA 24757

"SEE US AT PERSONAL COMPUTING '78 IN PHILADELPHIA, AUGUST 24-27"

Circle 75 on inquiry card.

The New WH17 "Mini" Floppy-a Giant Leap Forward in H8 Systems Sophistication!



Now you can give your H8 the power and versatility only a floppy disk system can provide! The WH17 lets you load programs in seconds instead of minutes, store hundreds of programs on a single disk with immediate access, update files virtually instantly. It's far more versatile and reliable than paper tape or cassette storage and really makes your H8 a "total capability" computer system!

Storage media for the WH17 consists of the standard, hard-sectored, 40-track diskette. Measuring just 5.25" in diameter, each disk offers the user access to 400 sectors (10 per track) or better than 102K* bytes of available program and data storage area.

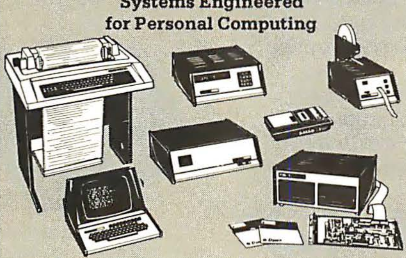
Supplied fully assembled, the WH17's model 82 WANGCO drive posts a conservative 30* ms track seek specification, and random sector typical access times of less than 350* ms. (A figure considerably better than that of many equivalent competitive drives.)

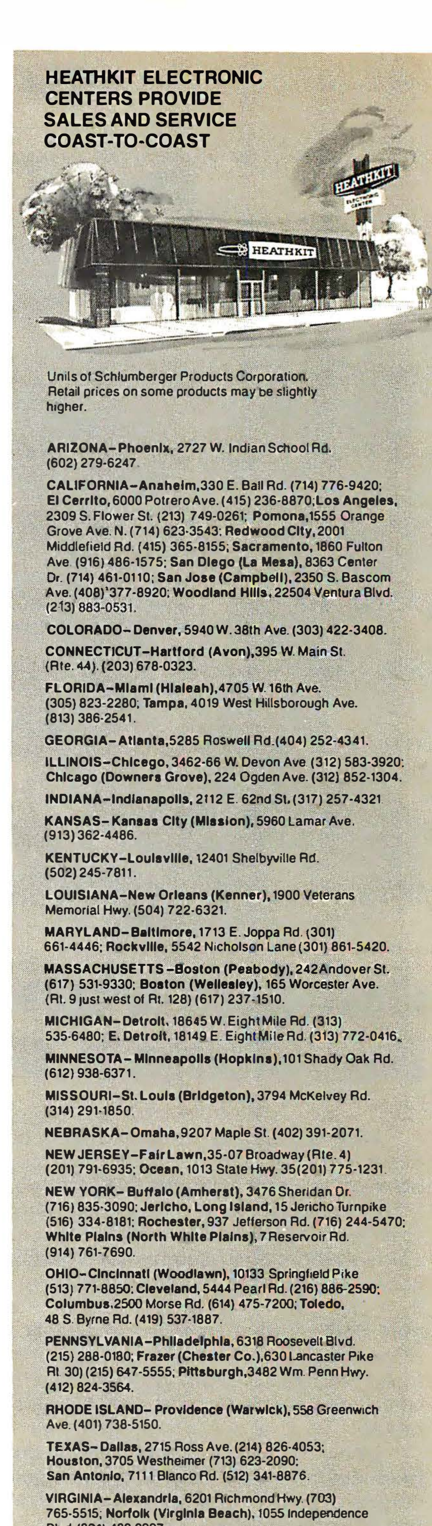
A diskette containing all required H8 operating systems is sold separately. This software includes the Heath Disk Operating System (HDOS), with its unique diagnostic, BUG-8, a console debugger, TED-8, our powerful text editor, HASL-8, and extended Benton Harbor BASIC.

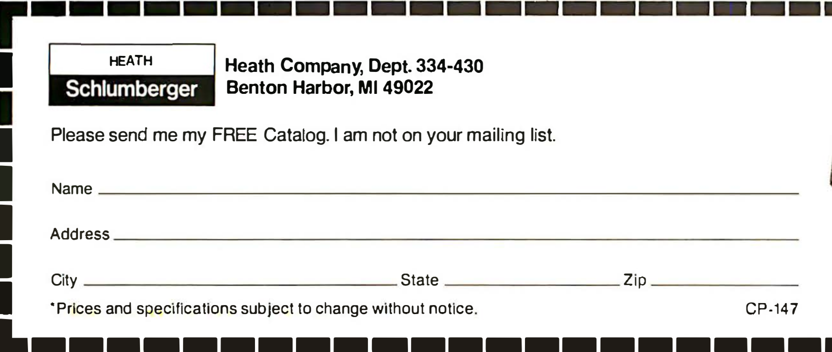
The fully assembled WH17, with dual-drive, controller and systems software, will be available in June, 1978, for $975.

HEATHKIT COMPUTERS

Systems Engineered for Personal Computing







HEATH Schlumberger

Heath Company, Dept. 334-430
Benton Harbor, MI 49022

Please send me my FREE Catalog. I am not on your mailing list.

Name ______________________________

Address ______________________________

City ____________ State ____________ Zip ____________

*Prices and specifications subject to change without notice. CP-147



FREE HEATHKIT CATALOG

Read about nearly 400 money-saving, fun-to-build electronic kits.

Use coupon to send for your mail order catalog or bring coupon to a Heathkit Electronic Center for your catalog.

Get Your Copy Today!

Circle 160 on inquiry card.

level 1 (highest)

level 2

level 3 (lowest)

Figure 1: A basic top-down design diagram is a structure like this. The number of levels may vary, and the number of boxes may vary, but the basic idea is given by this prototype.

checkbook
bank stmt
deposit slips
checks

implied inputs

balance checkbook

implied outputs

comparison of checkbook and bank balances
errors
corrections

Figure 2: The first level of design is the act of saying "I want a program to do thus and so." Here "thus and so" is defined to mean checkbook balancing.

The basic principle of top-down design procedure says that you start at a very high level of function definition and then progressively expand that function into more and more detail until you're at a low enough level to begin coding your program. Actually, this is a very natural way to design solutions to any problem, but, for some reason, this method was very slowly applied to programming. The top-down method is different from bottom-up, where the concern is for coding and details before a real program design has been done. Bottom-up methods work on the "how" aspects of the program before the "what" aspects. An analogy of this method would be the building of a house, using no structural plans, by first laying down a convenient foundation and then gradually adding wood and stone until some desirable structure has evolved.

Let's take an example of a function that could be performed on a microprocessor system for the purpose of illustrating the technique of modular, top-down program design. The function, monthly checkbook balancing, was selected because it is a process that is familiar to most of us and it contains all of the elements which make it a good example.

In order to design what you want the program to do, begin by drawing a multilevel design diagram like the one shown in figure 1. The diagram will describe what the program does at a number of different levels of detail, starting with the highest level which is a single block describing the overall function. The next lower level of blocks breaks the higher level function into a number of more detailed subfunctions. The next level takes those blocks and breaks them into even greater detail, and so on. An important point to remember is that the total function of the program is represented at each level.

Figure 2 illustrates the first steps in the top-down design of your checkbook balancing program. The first block simply states that the program will balance your checkbook. There are no details in that block and it certainly doesn't invite coding at this point in the design. For input, you know that you will have your checkbook entries, monthly statement from the bank, deposit slips and cancelled checks. The output you want is a comparison of your checkbook balance (adjusted for recent deposits, service charges and outstanding checks) and the balance shown on the bank statement. You also want to know where any errors were made and what corrections are required.

The second level of design, shown in figure 3, breaks the first level block into three major subfunctions. Although this subdivision could have been done differently in terms of the content of the second level blocks, the sum total of those functions always adds up to the entire function of the program. The idea is that you start the process slowly and don't attempt to develop too much detail too soon. Keep the number of subfunctions small, five or fewer, under

Figure 3: Once the first level of design has been determined, the next level is specified by breaking up the task into parts which are fundamentally independent of one another. Here, checkbook balancing is viewed as three separate modules of function.

balance checkbook

balance deposits

balance checks and charges

compare bank and checkbook balances

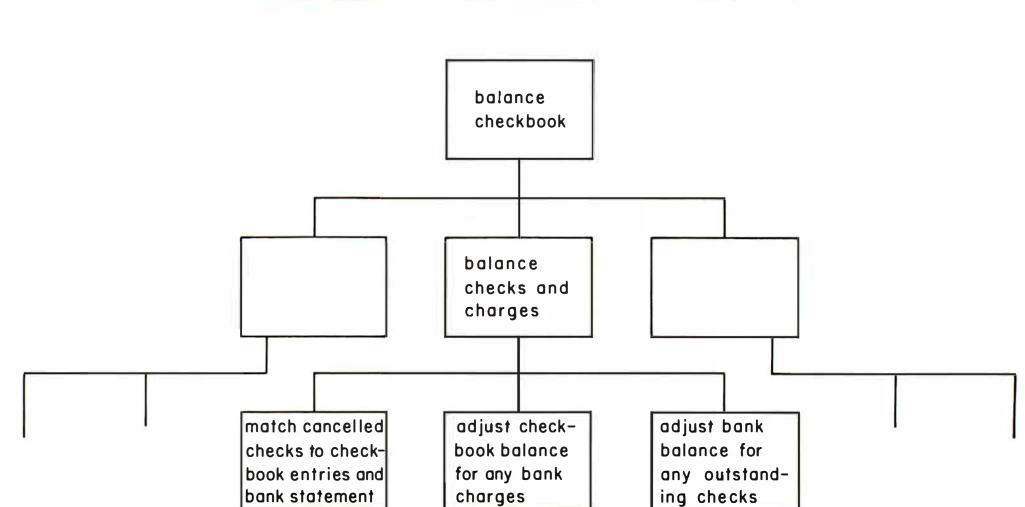


Figure 4: Carrying the process one step further, the next level is shown here for one of the branches of the structure of the programs.

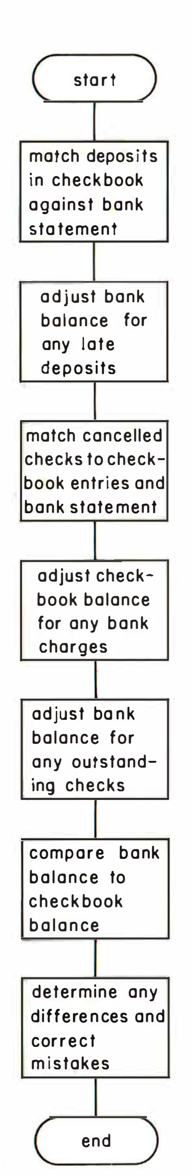


Figure 5: After the modular structure of the application is determined in a hierarchy such as those exemplified in figures 1 to 4, then attention can be given to sequencing of functions. This flowchart shows general level sequencing of the checkbook balancing application.

each function block. Don't worry about the order in which these subfunctions will be performed in your program. Remember, you're only concerned at this point about what is to be done, not how it is to be done.

Next, take the design to the next lower level by further subdividing each of the second level blocks. Figure 4 illustrates a portion of this step. Just make sure that each subblock represents a complete subfunction and that the subfunctions at any level are equivalent to the program function.

You might ask at this point, "How many levels must I go through?", or "How do I know when to stop?" There is no precise answer to these questions, although the following guidelines should help. In general, you will find that you should stop when the lowest level of functions is so simple that you can easily write a program module to do each one. A module should be considered to have about 50 program instructions, or less. Experience will help you to know when you have reached this point. Also, you will find that the more complex the program, the more design levels you will need; generally, about three or four levels will be sufficient.

Another method of determining if you've carried the design to a low enough level comes about almost automatically. If you are attempting to complete one of the lower levels and you find that the order of subfunction execution is becoming difficult to ignore, then you've probably gone far enough. Also, if you find that it is becoming necessary to show that program branching or decision making is required (top-down design diagrams should show no decision logic), then you know that you have about the right level of design. You are now ready to start thinking about the how of your program.

Modular Construction.

If you try to make each block at the lowest level of your design diagram into a module, you might determine that some blocks are simple and can be combined into fewer modules. On the other hand, there will probably be blocks which would result in modules larger than the minimum size of 50 instructions we have established. In this case, take the blocks through one or more additional levels of design.

Now decide what sequence the functions should be performed in. Begin drawing a

Rackets or Racquets?

Software systems from TSC serve—whether your racket is business or pleasure. TSC's software is designed for business and industrial uses as well as for recreation. Off the job or at work, TSC software serves your needs.



Assembly Language Programs
(Includes Source Listings)

With Object Code Cassette

SL68-5C 6800 Space Voyage	$18.95
SL68-24C 6800 Text Editing System	$30.45
SL68-26C 6800 Mnemonic Assembler	$30.45
SL68-29C 6800 Text Processing System	$38.95

With Object Code Paper Tape

SL68-24P 6800 Text Editing System	$31.50
SL68-26P 6800 Mnemonic Assembler	$31.50
SL68-29P 6800 Text Processing System	$40.00
SL80-10P 8080 Text Editing System	$37.50
SL80-11P 8080 Text Processing System	$41.00

Cassettes are in the Kansas City Standard format. Many other programs are available. Send 25¢ for a complete catalog.

To Order: Include 3% postage, $1.00 handling on orders under $10.00, and Indiana residents add 4% sales tax. Check your dealer!

TSC Monthly Feature:

8080 Mnemonic Assembler

This is the most complete resident non-macro assembler available for the 8080 and the complete source listing is included! The assembler is fully Intel compatible except for logical expression operators. All standard pseudo-ops are supported plus features such as paging, titling, spacing, listing suppression, sorted symbol table, Intel format tape generation, hex or octal output, decimal line numbers, auto field formatting, hex, decimal, octal or binary constants, and more. 5.5K of RAM is required beginning at 1000 hex, plus source and symbol table space. An object code paper tape in Intel ASCII format is available.

SL80-12	8080 Mnemonic Assembler	$25.00
SL80-12P	Assembler with paper tape	$34.00



Technical Systems Consultants, Inc.
Box 2574
W. Lafayette, Indiana 47906
317-423-5465

Specialists in Software & Hardware for Industry & the Hobbyist

Circle 370 on inquiry card.

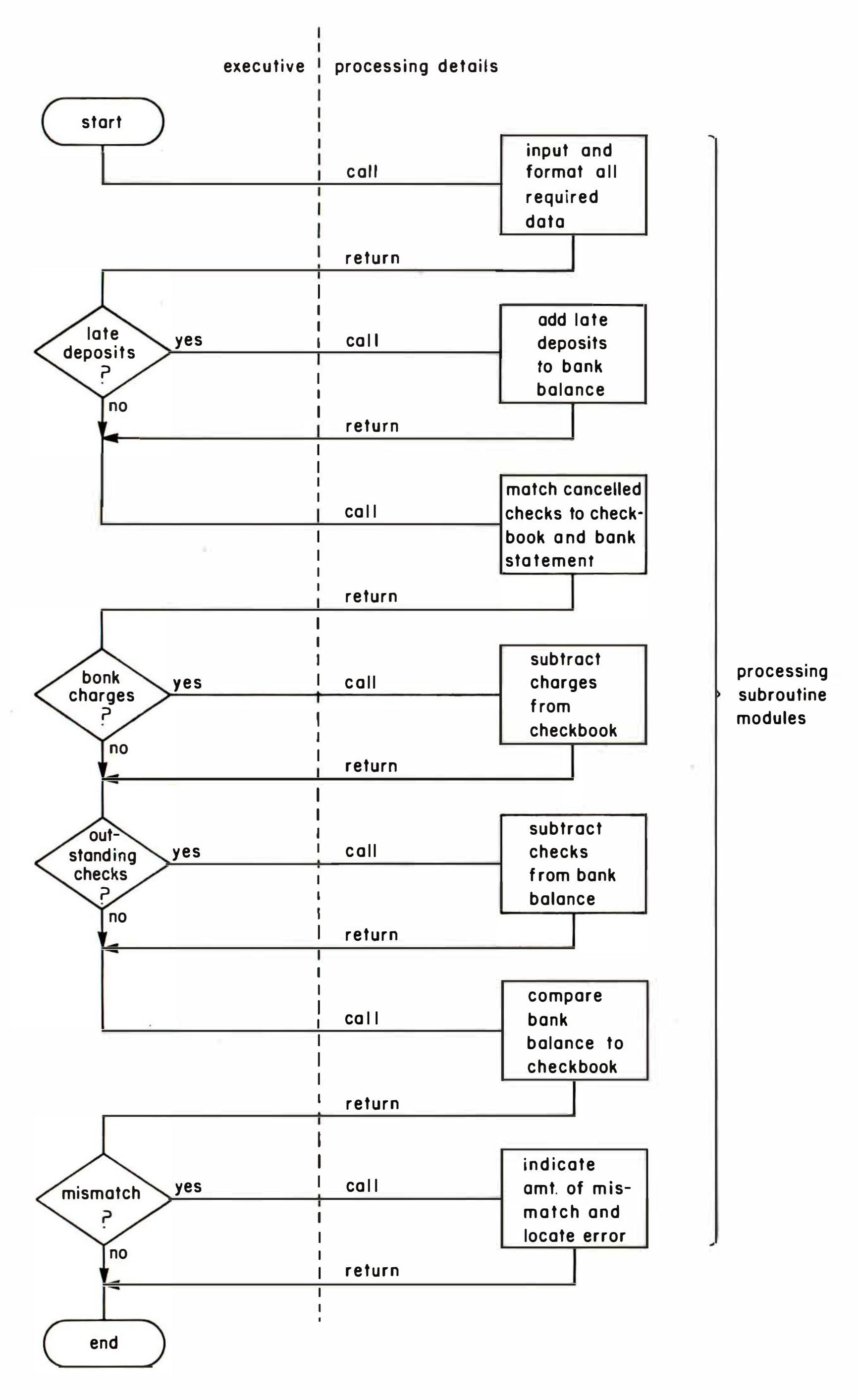


Figure 6: While the sequencing of the diagram shown in figure 5 is adequate, it is often useful to explicitly partition all sequencing of execution in a separate module called the "executive" for the application. This flowchart shows a simple example of such an executive program which sequences the major operations of the application.

flowchart showing the required sequence. Will each function be performed for each pass through the program? If not, add decision blocks showing the conditions under which each such function is executed. Also add any function blocks which may be necessary to initialize data, clear tables, IO data, etc.

Figure 5 shows a sequence of functions which results from the design of your example checkbook balancing program. Actually, the functions shown are probably too high level for this step, but for the sake of illustration, the diagram should make the point.

At this time, I would recommend that you consider making use of a special program structure called an executive routine, which offers some significant advantages. The executive is the main routine in the program and primarily contains calls to the function modules which do all the processing duties. It makes all decisions about the sequence of execution. It also contains the starting and ending points of the program. The objective of the executive is to concentrate most of the decision logic and common function of the program into a separate routine which becomes another program module.

In this way, the function modules need not, and should not, make sequencing decisions. They should never directly pass control to another function module. This should be done only through the executive. A function module's only responsibility is to be given control by the executive, do its assigned job, and then return control back to the executive. Function modules are written in the form of subroutines using the call and return facilities of the programming language being used. They should also contain a generous sprinkling of comment statements to insure a high degree of understandability, as well as a well-defined IO interface to the outside world and the rest of the program.

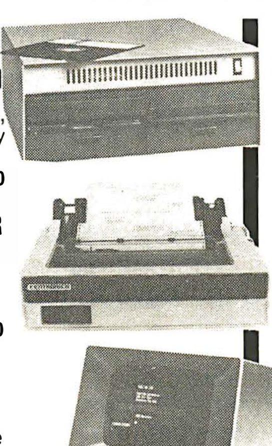
Figure 6 illustrates the final step in the modular, top-down design of your checkbook balancing program. You have added an executive routine and some necessary housekeeping routines. You could begin coding the program from this flowchart by first writing the executive and the associated subroutine calls for each of the processing modules. By writing dummy subroutines which simply return control when they are called, you can test your executive for correct operation without the need for the real processing modules.

The next step, of course, is writing the processing routines. This is simplified by the design approach described in this article because it allows you to work on each routine as a separate unit which can be written and tested independently of all other routines in the program. When all routines are completed, they simply plug into the executive to form a total program. Later, if you want to change the sequence of execution, add or delete functions, it can be simply a matter of manipulating modular routines. ■

HOW TO BEAT THE SYSTEM WITH SYNCHRO-SOUND

High-performance, low cost complete Microcomputer Business Systems (plus Software) at EXTRA savings only Synchro-Sound can offer!

SYSTEM No. 1



DIGITAL SYSTEMS DSC-2 Z-80 COMPUTER SYSTEM

32K RAM, 4 RS-232 serial interfaces, 16 bits of parallel I/O. Double density floppy disk, Shugart dual-drive.

Regular price $4995.00

CENTRONICS 700 PRINTER With RS-232 Interface

60 characters per second, 132 column line, tractor feed.

Regular price $1720.00

HAZELTINE 1500 VIDEO TERMINAL

80 character lines, 24 line page, line and page editing. Separate numeric keypad.

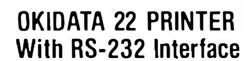
Regular price $1149.00

$7864.00

THE COMPLETE SYSTEM ONLY $7495.00

SAVE $369.00!

SYSTEM No. 2



IMSAI VDP 80 DATA PROCESSING COMPUTER SYSTEM

32K RAM, expandable to 196K. Parallel and serial I/O. Megabyte mass storage, alphanumeric intelligent keyboard.

Regular Price $6995.00

OKIDATA 22 PRINTER With RS-232 Interface

Tractor feed, 132 column, 125 lpm, upper and lower case. 12 different fonts on command.

Regular price $2888.00

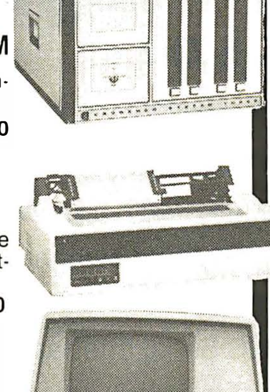
$9883.00

THE COMPLETE SYSTEM ONLY $9445.00

SAVE $438.00!



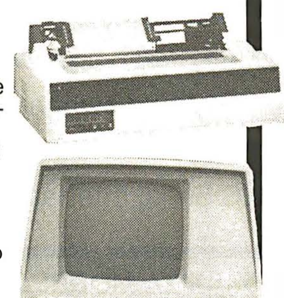
SYSTEM No. 3



CROMEMCO SYSTEM 3 Z-80 COMPUTER SYSTEM

32K RAM, dual disk drive, RS-232 Interface. S-100 bus.

Regular price $5990.00



MODEL 3703 LINE PRINTER

180 characters per second, print line width 132 cols., bi-directional printing.

Regular price $2995.00



CRT TERMINAL MODEL 3100

80 characters per line, 24 lines, up to 19,200 baud, upper and lower case.

Regular price $1595.00

$10,580.00

THE COMPLETE SYSTEM ONLY $10,095.00

SAVE $485.00!

SOFTWARE

Three software packages* that enable you to profitably make full use of your Microcomputer Business System

ACCOUNTS RECEIVABLE PACKAGE Creates transaction file of charges, credits and payments. Batch mode for monthly statements and aged schedules.
Operators manual and disk, single copy **$500.00**

INVENTORY PACKAGE Maintains current listing of stock items, master inventory listing with price and cost data.
Operators manual and disk, single copy **$500.00**

ORDER-ENTRY PACKAGE (Requires Accounts Receivable and/or Inventory Package) Links Accounts Receivable and Inventory packages into one coherent, easy-to-use, time-saving system.
Operators manual and disk, single copy **$500.00**

Buy any of our 3 MICROCOMPUTER SYSTEMS and any combination of these 3 SOFTWARE PACKAGES ARE YOURS FOR

HALF PRICE!

* Require 48K Memory and Microsoft Basic

Terminal and Printer substitutions may be made on any of the above Systems

CUSTOMIZED HARDWARE SYSTEMS ARE AVAILABLE

Complete modern servicing and consulting facilities on premises



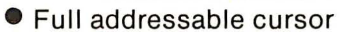
SYNCHRO-SOUND ENTERPRISES, INC.
The Computer People
193-25 Jamaica Avenue,
Jamaica, New York 11423
212/468-7067 TWX: 710-582-5886
Hours 9-4 daily and Saturday
Visit our new showroom
Working units on display
Dept BSY
BankAmericard • Master Charge

SYNCHRO-SOUND

ENTERPRISES, INC.

One-stop shopping for Hardware and Software

Everything you need in small computer systems with special emphasis on TERMINALS! Look at these units...compare price, quality, delivery, service...and you'll see why you don't have to look anyplace else!



LEAR SIEGLER ADM 3A TERMINAL

- Full addressable cursor
- Display format—24 lines of 80 characters per line
- Communications rates—75 to 19,200 Baud
- Computer interfaces —EIA standard

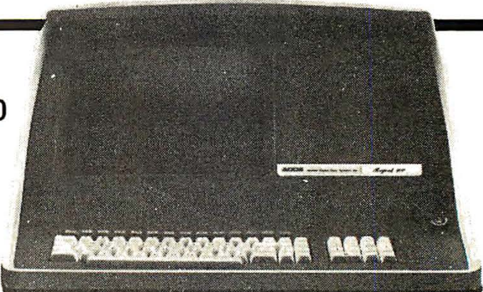
ADM 3A Kit **$759.95**
ADM 3A Assembled .. **854.95**
Lower Case option **69.00**

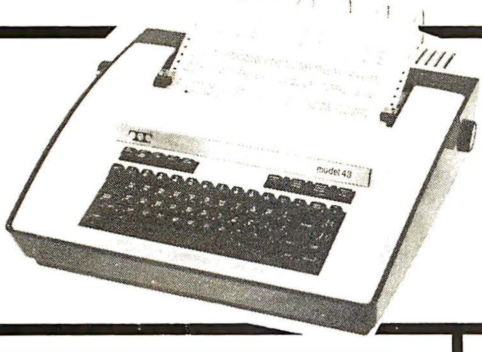


ADDS REGENT 100 VIDEO DISPLAY TERMINAL

Display Format—80 characters per line by 24 lines. 25th line reserved for terminal status. Reverse video, underline, half and zero intensity and blinking are all standard features.

$1325.00





TELETYPE MODEL 43 PRINTER

- 132 Characters per line
- 110 or 300 Baud switch selectable
- Full keyboard
- RS 232C Serial Interface standard

$1299.00

OKIDATA MODEL 110 LINE PRINTER

- 110 CPS dot matrix

Friction Feed ... **$1199.00**
Tractor Feed..... **1349.00**
RS 232C Serial Interface ... **260.00**



OKIDATA MODEL 22 LINE PRINTER



- 125 lines per minute 132-column print line
- Upper/lower case
- 8 different character sizes
- 12 IPS paper slew

Tractor Feed **$2449.00**
RS 232C Serial Interface... **379.00**

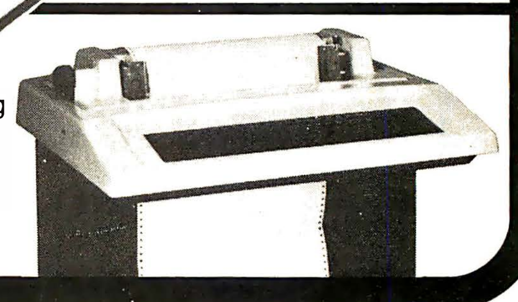


DECWRITER II

- 132 column printing
- 10-30 CPS
- Full keyboard
- Tractor feed

$1495.00





Who's Afraid of Dynamic Memories?

Lane T Hauck
Director of Research and Development
Noval Inc
8401 Aero Dr
San Diego CA 92123

(Conversation overheard in local computer store):

> Customer: *What's the difference between static and dynamic memory?*
> Salesman: *Static memory works and dynamic memory doesn't.*

It is unfortunate that the dynamic memory has had a rocky start in the small systems world, but it is not really surprising. The dynamic programmable memory is a part generally avoided by most designers because it is not nearly as simple to use as static memory. But taking the extra trouble and design care can pay handsome cost and performance dividends, since the dynamic memory is inherently a lower cost part than its static counterpart (by present standards of technology).

The purpose of this article is to remove some of the mystery about dynamic memory parts. In order to best cover all the trade-offs involved in a dynamic memory design, the discussion centers around the design of an actual dynamic programmable memory with the following specifications:

1. 32 K bytes on one card.
2. Altair (S-100) bus compatible (an elusive specification, as we'll see later).
3. Refresh mechanism invisible to the processor.
4. Lowest power dissipation possible with current integrated circuits.
5. Full speed operation in a 2 mHz system (no wait states).
6. Foolproof operation: refresh maintained despite halted processor and direct memory access operations, interrupts and prolonged wait states.

It is not necessary to refresh *every* cell of the dynamic programmable memory individually, but only the rows of the memory matrix.

Note: *A commonly seen misnomer is the abbreviation "RAM" used to refer to a typical volatile programmable memory part such as those discussed in this article. RAM stands for "random access memory," which is descriptive of any memory part which addresses a unique memory cell given a set of binary inputs. A "read only memory" for example is also a random access memory, yet it is quite different in function from the volatile programmable memories. Thus in reading advertisements and manufacturers' literature, be aware that the term RAM as used really means "volatile programmable memory," a resource for the programmer who uses the system. . .*CH

Figure 1 is the usual starting point in any discussion of programmable memory. It is shown here only to point out that the static programmable memory cell uses six MOS transistors, while the dynamic cell uses only one (end of cost advantage argument).

The dynamic programmable memory cell uses a charge storage technique to store digital information. The capacitor C_C in figure 1b is charged for one logic state and discharged for the opposite state. Capacitors, being what they are, don't hold charge forever (due to leakage), so the cell shown works fine, but only for a few milliseconds. After that, the charge decays below a usable value. This is the reason for the mechanism called *refresh*. A refresh operation reads the value of the charge on the capacitor, amplifies it to its initial value, and dumps it back into the capacitor.

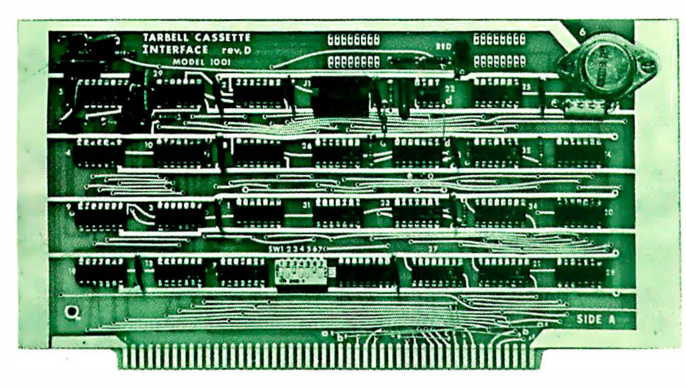
Life would really be difficult if the designer had to implement the entire refresh operation (read, amplify, write) in a dynamic memory system. Dynamic memory designers have made things simple by establishing the following refresh "rules":

1. It is not necessary to refresh *every cell* in the dynamic memory individually, but only the *rows* of the memory matrix.
2. A refresh operation is accomplished by simply *accessing* the required number of rows with any type of memory operation (read, write, or do nothing but set up the correct addresses accompanied by a "strobe" or timing pulse).

Programmable memories are organized in an XY matrix of rows and columns. The matrix is generally square, so it is possible to deduce the number of rows in the memory that must be accessed during

TARBELL SETS STANDARDS
For Hobbyists and Systems Developers

Sales to thousands of hobbyists over the past two years have proven the Tarbell Cassette Interface to be a microcomputer industry standard. Tarbell Electronics continues research and development to produce new and efficient components to fill hobbyists' changing needs.

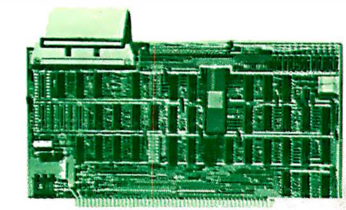


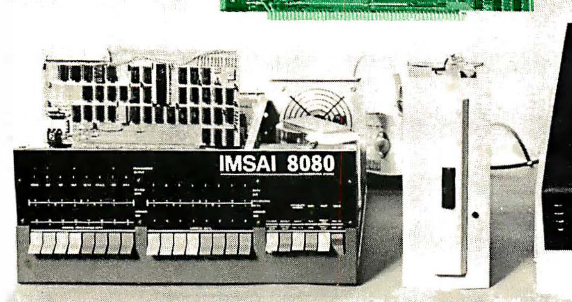
TARBELL CASSETTE INTERFACE

- Plugs directly into your IMSAI or ALTAIR*
- Fastest transfer rate: 187 (standard) to 540 bytes/second
- Extremely Reliable—Phase encoded (self-clocking)
- 4 Extra Status Lines, 4 Extra Control Lines
- 37-page manual included
- Device Code Selectable by DIP-switch
- Capable of Generating Kansas City tapes also
- No modification required on audio cassette recorder
- Complete kit $120, Assembled $175, Manual $4
- Full 6 month warranty on kit and assembled units

TARBELL FLOPPY DISC INTERFACE

- Plugs directly into your IMSAI or ALTAIR* and handles up to 4 standard single drives in daisy-chain.
- Operates at standard 250K bits per second on normal disc format capacity of 256K bytes.
- Works with modified CP/M* Operating System and BASIC-E Compiler.
- Hardware includes 4 extra IC slots, built-in phantom bootstrap and on-board crystal clock. Uses WD 1771 LSI Chip.
- Full 6-month warranty and extensive documentation.
- PRICE:
  Kit $190 ...... Assembled $265





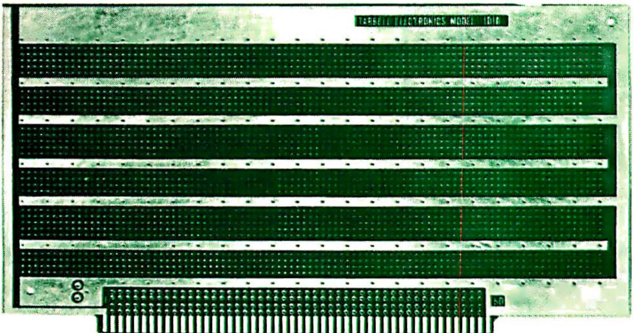


CP/M with BASIC-E and manuals: $100

Compatible Disc Drives

Ask about our disc drives priced as low as $525.

TARBELL PROTOTYPE BOARD
Model 1010



- Gold plated edge pins
- Takes 33 14-pin ICs or
- Mix 40-pin, 18-pin, 16-pin and 14-pin ICs
- Location for 5 volt regulator
- Suitable for solder and wire wrap
- ALTAIR/IMSAI compatible

Price: $28.00

For fast, off the shelf delivery, all Tarbell Electronics products may be purchased from computer store dealers across the country. Or write Tarbell Electronics direct for complete information.

*ALTAIR is a trademark/tradename of MITS, Inc.
CP/M is a trademark/tradename of Digital Research



20620 South Leapwood Avenue, Suite P
Carson, California 90746
(213) 538-4251

Circle 360 on inquiry card.

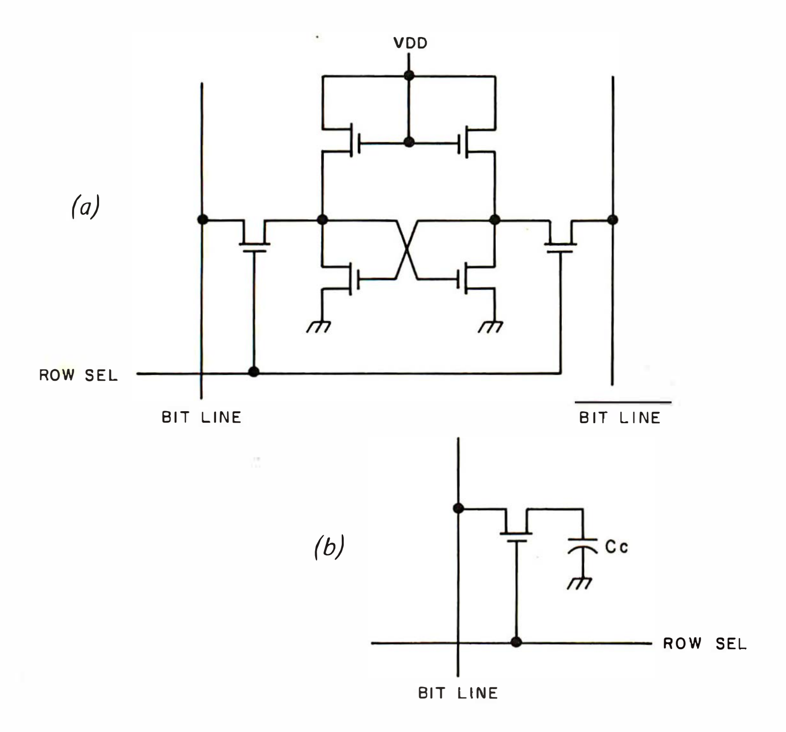


Figure 1: Comparison of static and dynamic memory cells. The static memory cell (figure 1a) is actually a flip flop (or bistable multivibrator) made up of six MOS transistors and capable of storing one bit of information. The dynamic memory cell (figure 1b) uses one MOS transistor and a capacitor to store one bit of information. The major differences between the two memory storage techniques are cost (dynamic memories are significantly cheaper than static memories) and the fact that dynamic memories must be "refreshed" regularly to maintain the charges on the capacitors.

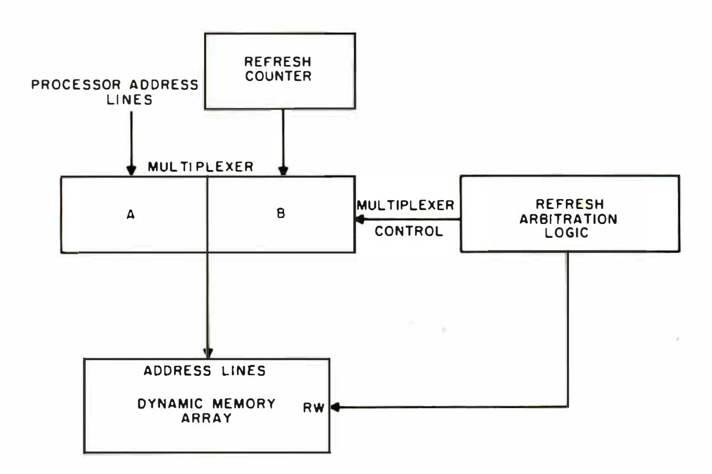


Figure 2: Refresh implementation block diagram. Dynamic memory cells must be refreshed periodically, or the capacitors used to store the bits of information will discharge. Refreshing is done by simply accessing the cells in question with any type of memory operation (read, write, or do nothing but set up and strobe the correct addresses). Because dynamic memory cells share common lines, it is necessary to access only the rows of the memory matrix. All dynamic memories are set up so that the row decoders are fed by the least significant address lines (A0 thru A5 for a 4 K part, for instance). The memory address lines are fed by a multiplexer that selects either the A lines (processor address lines) or the B lines (refresh counter lines) as directed by the refresh arbitration logic. The selected lines are then fed into the dynamic memory array. The refresh arbitration logic insures that the refresh operations and the processor operations do not interfere with each other.

a refresh interval. For example, a 4 K by 1 bit memory is 64 by 64, so 64 memory cycles must be performed for refresh; a 16 K by 1 bit memory is 128 by 128 and requires 128 refresh cycles. The specification for refresh interval is generally 2 ms. This means that all rows of the memory matrix must be "exercised" at least once every 2 ms.

How do you know where the "rows" are? All dynamic memories are set up so that the row decoders are fed by the least significant address lines; for a 4 K part, this means the six low order address lines, or A0, A1, A2, A3, A4 and A5. During the refresh operation, the remaining address lines A6 thru A11 are in "don't care" states. For a 16 K part, the seven low order address lines A0 thru A6 constitute the row address lines.

Figure 2 shows how refresh is accomplished. The memory address lines are fed by a multiplexer that selects address inputs from multiple sources. When the A inputs are selected, the processor accesses the memory; when the B inputs are selected, the refresh address counter accesses the memory. The role of the refresh arbitration logic is to insure that the refresh operations and processor access operations do not interfere with each other. The block diagram in figure 2 shows a 2 input multiplexer. A later section of this article shows how the number of inputs may be expanded to accommodate a multiplexed address programmable memory.

Some system designs allow the use of dynamic memories without having to implement any refresh circuitry whatsoever. The most common system of this type is a video system that uses raster scanning. In order to present a stable image on the video display, all information is stored in a refresh memory. As the electron beam scans the screen, a digital address that identifies the beam position is developed by the video display's timing circuitry and fed to the memory address lines. The memory thus sequences continuously through its addresses. This satisfies the refresh requirement automatically, since the refresh counter of figure 2 is in effect replaced by the video display's counters.

The 4 K dynamic memory is currently available in three different packages: 22 pin, 18 pin and 16 pin. The survivor of the incompatibility battle is clearly the 16 pin package, due largely to its superior design, low power and true compatibility between multiple sources. Ironically, the smallest package, the 16 pinner, was the easiest one to convert to a 16 K memory part. [*Several manufacturers of personal computers take advantage of this to offer memory in different combinations of 4 K and 16 K byte blocks . . .CM*] We'll see how this was done

A PROFESSIONAL COMPUTER TERMINAL FOR THE SERIOUS HOBBYIST. JUST $995.

The AJ 841 I/O. A completely refurbished IBM Selectric ASCII terminal with RS 232 or parallel interface.

FEATURES:

- ASCII code.
- 14.9 characters per second printout.
- Special introductory price — $995 (regularly $1,195). 75% discount from original price of new unit.
- Serial RS 232 or parallel interface.
- Order direct from factory.
- Documentation included.
- 30-day warranty — parts and labor.
- High quality Selectric printing.
- Reliable, heavy duty Selectric mechanism.
- Off-line use as typewriter.

$995.

AJ 841 WARRANTY AND SERVICE IS AVAILABLE IN THE FOLLOWING CITIES:

Los Angeles / Cincinnati
Philadelphia / Detroit
Hackensack / Dallas
Columbus / Houston
Cleveland / Atlanta
San Jose / Chicago
Boston / New York
Washington, D.C.

For further information call (408) 263-8520



Anderson Jacobson, Inc., 521 Charcot Avenue
San Jose, California 95131

Full warranty information available upon request

HOW TO ORDER AN AJ 841 I/O TERMINAL

1. Make cashier's check or money order payable to: **ANDERSON JACOBSON, INC.**
   Address your request to:
   Personal Computer Terminal
   ANDERSON JACOBSON, INC.
   521 Charcot Avenue
   San Jose, CA 95131
2. Upon written notification, pick up your terminal at the AJ service office located in one of the above cities. Allow six to eight weeks for delivery.
3. A final check of your unit will be made at the local AJ service office at time of pickup.
4. For warranty or repair service, return unit to designated service location.
5. Available in U.S. only.

CLIP AND MAIL WITH ORDER

SELECT EITHER: Interface: RS 232 ☐ or Parallel ☐
Keyboard: EBCD ☐ or Correspondence ☐

Number of units ______ @ $995 each $ ______

Sales tax at delivery location $ ______

Shipping and handling $35 each (excluding San Jose) $ ______

TOTAL $ ______

NAME ______

ADDRESS ______

CITY ______ STATE ______ ZIP ______

PHONE ( ) ______

Circle 10 on inquiry card.

The current wonder of the semiconductor world is the 16 K dynamic programmable memory.

when address multiplexing is discussed later in this article.

The current wonder of the semiconductor world is the 16 K dynamic programmable memory. The 16 K dynamic memory part that provides the prototype for the industry is the MOSTEK MK4116. This is the part that virtually all semiconductor memory makers are laboring to emulate, due to its high performance and low power. Intel is another large supplier of 16 K dynamic memories in the form of the 2116, but the 2116 dissipates much more power than the 4116 and is not truly compatible with the 4116 type part which the rest of the industry is lining up behind. Intel will shortly have a newly designed part that performs like the 4116. Texas Instruments is also in the process of redesigning their 16 pin part to perform like a 4116.

The 16 K dynamic memory is in high demand these days, and the suppliers have not begun to meet the demand. This spells bad news for the experimenter, because prices will remain high ($20 to $30 each even in high volume) until the suppliers catch up to the demand. The day the 16 K chip becomes a "jellybean" part, such as the 2102, is probably about two years off.

There is, however, a sneaky way that the 16 K part can be used economically *today.* Like all integrated circuits, the 16 K part undergoes thorough testing before it is packaged and sold as a part. The die size of the 16 K part is so large that the probability of something being wrong with one or a few array cells is fairly high. Clever manufacturers (presently MOSTEK and Intel) are taking the parts which have problems as a 16 K part, and retesting them to see if either of the two 8 K halves of the array function perfectly. And they do indeed find many parts which are perfectly acceptable 8 K parts. These parts are not factory "rejects": they meet all specifications for the 16 K device, but you can only use half of the part. Two part numbers specify the devices and tell the designer that a particular address line (A0) must be always high or always low. This permanently selects only the "good half."

If you look closely at some of the current dense Altair (S-100) bus compatible memory boards, you'll see these devices (Intel calls theirs the 2108; MOSTEK's is the 4115). This type of part makes everybody happy.

Continued on page 140

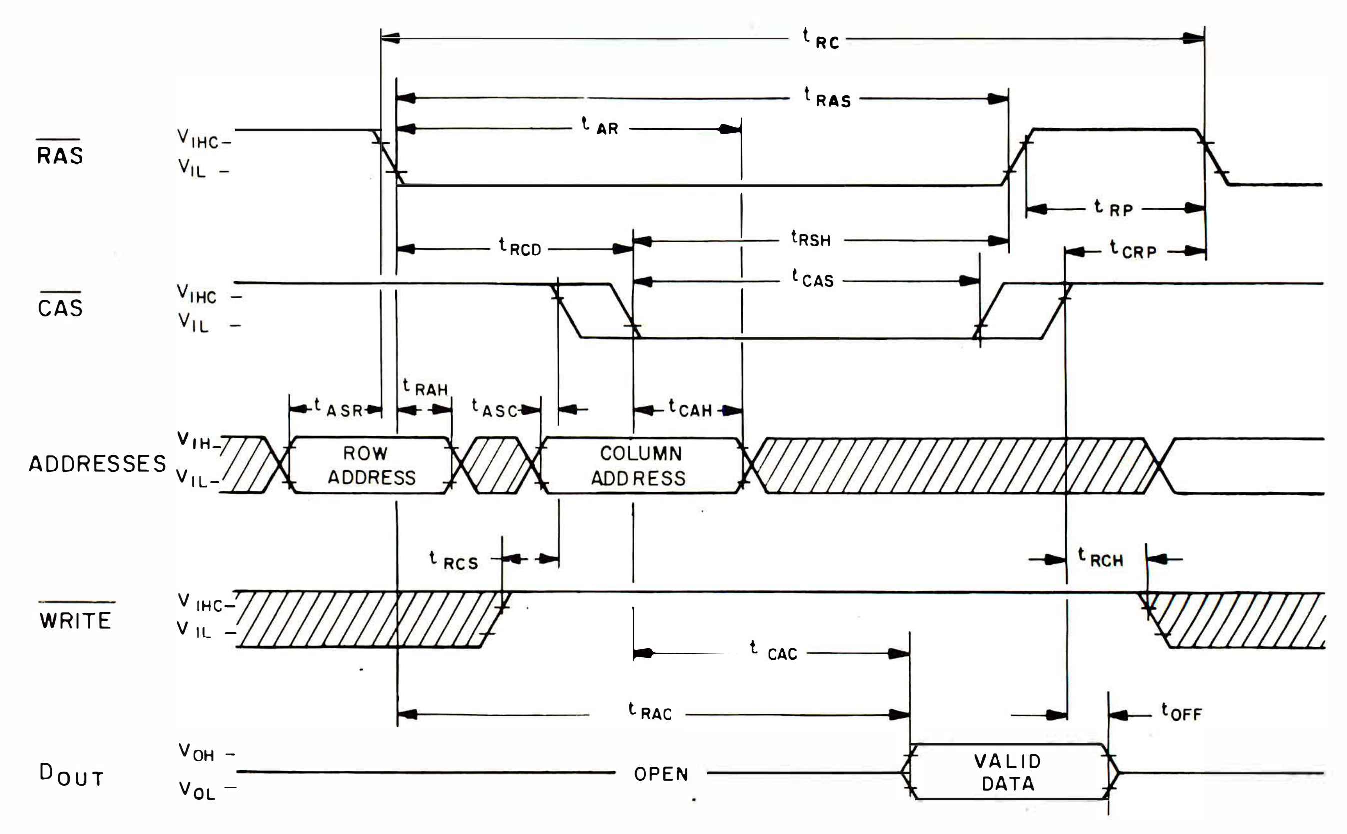


Figure 3: Dynamic memory timing for the MOSTEK MK4116 16 K dynamic memory (Courtesy MOSTEK). The following steps are necessary for a memory cycle: set up the low order 7 bit address on the address line (for the case of the 16 K memory) by setting the address multiplexer to state 2; wait for the address lines to settle; drop the row address strobe (RAS) line to the low state to latch the low address into the port; wait the "row address hold time"; set up the high order 7 bit address on the address lines; finally, drop the column address line to the low state, which latches the high address into the port.

GET THE REAL LOW DOWN BEFORE YOU BUY

SO YOU WANT TO BUY A COMPUTER??

This new book presents an objective look at the top 24 micro systems sold throughout the world.

It discusses the Pros and Cons of each system in No Uncertain Terms and takes a straightforward look at the micro computer industry as it relates to YOU.

Written especially for the layman in a language he can understand. Profit from the mistakes of others.

Includes hundreds of references.

Table of Contents

1. Introduction
2. Don't get hung up on the chips
3. Which category do you fit into
4. Now – About the Hardware
5. Peripherials that plug in?
6. What? No Software!
7. Helpful Suggestions before spending money
8. Addresses

$4.50 per Volume
Volume discounts available

SCIENTIFIC RESEARCH

P.O. Box 490099-B
Key Biscayne, Florida 33149

Phone Orders Call 800-327-6543





Add $1 handling, all domestic shipments sent U.P.S. except APO and P.O. Box which go parcel post. Foreign orders add $4 for air shipment and make payable in U.S. funds.

Antique Mechanical Computers

Part 1: Early Automata

Dr James M Williams
58 Trumbull St
New Haven CT 06510

There is a high technology in every age, not just our own.

My purpose in writing these articles is to remind computer enthusiasts that there is a high technology in every age, not just our own. Described herein are some of the stellar accomplishments of earlier times. The technology of electronics is merely the latest link in a continuous chain of technological developments spanning 20,000 years. Before that, there was a mechanical technology.

Part 1 of this three part series describes some highlights in the development of automata up to the 18th century. Part 2 continues with 18th and 19th century developments, and part 3 concludes with a description of Torres' 1911 chess automaton.

I am not going to speak here of those incandescent moments long ago when the truly great and critical achievements of mechanics were discovered: that day when an ancient man hooked a stick under one large stone and over another to invent the lever. Nor will I consider the wheel, which, however it came about, multiplied mechanical possibilities so manyfold (pulley, cam, gear, crank, escapement) that as the knowledge spread humanity was irrevocably changed. We simply do not know the story of mechanical knowledge and its spread, so we must spin scenarios instead of histories. We will also have to concentrate on highlights, since an exhaustive treatment of mechanical computers would fill many books.

We do know most of the latest chapter, however. It has taken place in the past 350 years, beginning in Renaissance times, flourishing in the Industrial Revolution, and finally levelling off in the early years of this century. The mechanisms that are now commonplace were being born back then, and what exciting times they must have been. Glance through a compilation of mechanisms and note the dates of first appearances in machinery. You will be surprised to see how many basic movements date from two centuries ago. And with study and application, a man could learn them, make them his own, and employ them in mechanisms of his own. Consider the thrill of the obscure local blacksmith in, say, Saxony 400 years ago who copied in wood the mechanism of the town clock's striking-jack — the clock, a wonder that was the envy of other towns, imported at great expense from Italy — and discovered for himself the means of transforming rotary motion into intermittent linear motion, via a cam. (Medieval cathedral clocks generally had a life-size figure, man, angel, or devil, which carried a mace to strike hours on a bell: the "striking-Jacques" or "striking-jack.") Imagine the challenge and excitement in realizing that one could construct a clock that would strike noon fairly consistently when the shadow of the church steeple touches a particular joint of flagstone in the village square. Could one compress this wonderous mechanism into a container small enough to carry, and be able to see the time whenever he wished? Could one construct a clock for the pocket?

The first ones showed up around 1650, bulky as an ostrich egg and not much better at keeping reliable time. A little over two centuries ago a carpenter from Yorkshire, England, James Harrison, who had taught himself mechanics over a period of 30 years, constructed his fourth highly



Photo 1: The bird organ, a popular novelty of the 18th and 19th centuries. The device is a sophisticated automaton capable of imitating the sound and movements of a real bird: the wings flap, the head turns, and the beak moves to the accompaniment of assorted bird whistles.

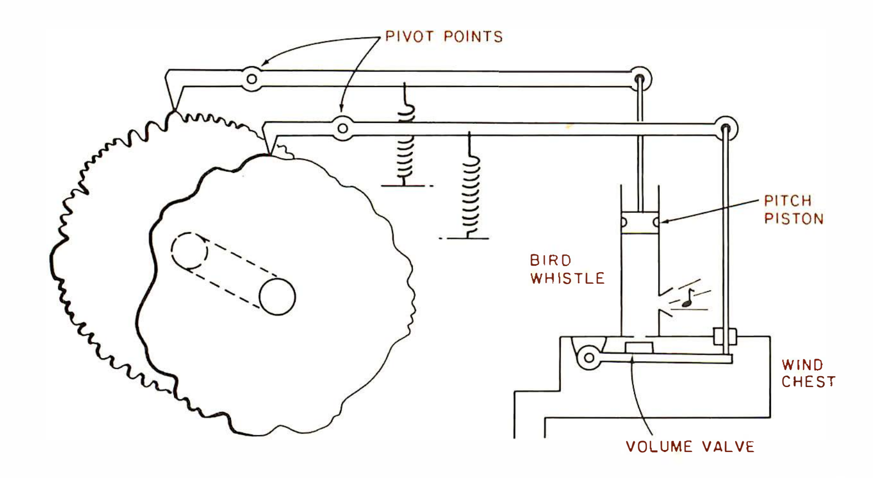


Figure 1: Schematic diagram of a typical bird organ mechanism. Two metal cams control the bird's voice: the far cam controls the pitch piston (located in the body of the bird whistle), and the near cam controls the volume valve (located inside the wind chest).

accurate watch (chronometer) and won a prize of £20,000 from the British government in 1760. Determined to make the British Navy the master of the seas, the Admiralty offered a prize for a watch that would permit a ship to calculate its longitude with an accuracy of 60 nautical miles after being at sea for six weeks. (Latitude is relatively easy to calculate by accurately measuring the elevation above the horizon of any celestial body. Longitude is more difficult, and requires knowing the elevation at a *time* known relative to a fixed reference, the zero meridian at Greenwich, England.)

Mechanicians (an excellent name for the practitioners of this craft) chose to work in the field for much the same reasons we all choose a field today: because it was an absorbing and genteel means of earning a living, because it offered accomplishments one could show with pride, and because it was the area for future expansion, the growing edge of the technology. Look at the legacy of machines they have left us: the Linotype, the typewriter and its relatives, the reproducing piano (and its less intelligent cousin, the player piano), clocks and watches of every description. They are all fine mechanisms, but most of them were perfected and essentially attained their present configuration 80 years ago and more. Electronic devices have displaced most of them.

The flowering of mechanical technology had other branches that have now died out, though, leaving only accounts in books and a few decaying museum specimens of machinery which once stirred general admiration and brought fame to their creators: the Orrery, a clockwork model of the solar system, complete with moons, that once stood proudly in the exhibition room of every significant university; the dazzling variety of music boxes which once were found in every parlor; and so on. And who nowadays recalls the bird organ (see photo 1 and figure 1)?

The bird organ was a mechanical device that produced a very close simulation of a bird's song; 200 years ago it was a very expensive and much cherished ornament in the parlor of every gentle home. I have seen electronic versions of circuits for such a device and have built one, but together with its transformer and loudspeaker it occupies most of the space in a small birdhouse. A commercial version I purchased is slightly smaller, housed in a 3 inch plastic sphere. Around the year 1800 there was a bird organ made for sale to replace the

head of a gentleman's walking stick. A hinged lid sprang open by a concealed catch, and out popped a minute feather covered bird model that opened its beak, spread its wings and sang. The entire device, except for its winding key, was housed in a gold ornamented cylinder 1½ by 2 inches (3.8 by 5 cm) long. How's that for miniaturization? And I'll wager it made a better song than my blocking oscillator version.

There were bird organs, or accounts of them, in antiquity. The Greeks used steam or air to drive whistles mounted in bird figures; the Arabs and Persians supposedly did the same. The mechanism was sometimes a cluster of tuned whistles like a bank of miniature organ pipes, and this arrangement is found in a clock from 1750, but the modern bird organ dates from about 1770 and was likely devised as a means of teaching domesticated songbirds to sing. Soon miniaturized, it was incorporated into decorative objets d'art of all sorts: snuff boxes, perfume flasks, table centerpieces (these often had small fountains of water and other distractions built in), clocks, even watches (but these were very rare), and free standing forms. One delightful version of the latter, perhaps 9 inches (23 cm) high, depicts a lady seated at her desk and a bird on a perch pole nearby. Her hand is on a (mock) bird organ, which she cranks while her pet listens attentively. The bird then tries to copy the song, but makes errors, which she corrects by playing the lesson again so that the bird "learns" and repeats it accurately, with much enthusiastic flapping of wings, pivoting on the perch, etc.

In computer terms, the bird organ can be described as a spring driven power train controlled by a mechanical read only memory.

Large or small, the mechanism of bird organs was always the same (see figure 1): a main spring drove a gear train which operated a bellows to compress air in a wind box, and another gear train drove an intricately cut cam which, via a piston, varied the pitch of a whistle connected to the air supply. A similar cam operated a valve to control the volume of the whistle tone. More gears drove cams that controlled the beak, wings, and pivoting actions via push wires ascending the perch pole and the bird's hollow legs. Songs of eight or nine species are to be found among bird organ mechanisms (some elaborate devices had double or triple songs), and the nightingale was most popular. Remember the fairy tale about the mechanical nightingale by brothers Grimm, about 1855? It lived in a jewelled tree, and some devices were made in this form, but the objet d'art was perhaps most popular, being finished in enamel and gold and frequently decorated with precious stones. While bird organs were essentially one of a kind machines, there was a sort of production line for them maintained by the most famous makers, and many thousands of them exist in museums. A great many were exported from France and Switzerland to the Orient. They are still made, and, while expensive, they are no longer the luxury of rich men. [*A German bird organ about the size of a pocket calculator is currently available for under $400 . . .* CM]

In computer terms, the complete mechanism might be described as a spring driven power train controlled by a mechanical read only memory whose values are stored as a distance of the edge of the cam from the cam's center of rotation. In 45 seconds of singing, there might be a fair number of places where the notes sound, perhaps, six to eight per second (during a trill).

Referring to figure 1, if we have two cams which rotate in 45 seconds, and we allow a time division of ten samples per second, and if we allow eight bits of precision per sample, we would require 900 bytes of read only memory to simulate the control functions of these cams.

A longer song, as in the tutorial automaton described above, might require three times as many bytes together with a smaller number to control bird and figure motion. This gives a total of 3 K bytes of mechanical read only memory divided unequally among several cams (something approaching the storage capacity of contemporary read only memory parts).

A better way to look at this sort of mechanism might be as a computer with analog storage (varying cam curves) and analog output (varying positions of the volume valve and pitch piston). Information is stored in the intricate curves of the cams. The information is fixed there for all time, or until wear or rust alter it, and may be recovered whenever it is needed by rotating the cam while the cam-follower rides on its periphery. It is in every way an "analog" of the desired sound, but it is not a recording, because it has been distorted in storage to suit the particular readout mechanism being employed (the cam-follower). (I have described the stored information as digital in order to facilitate the comparison; this has validity because of the relatively small number of analog positions and their resolvability into bytes of restricted number.) Even in the 1770 to 1850 era the cam was not a new invention, but this application was novel. It was a benchmark in the field of mechanics. Storage of information had now become a tool of the mechanician, where formerly mere repetitive movement, the regular back and forth movement of a

clock's mechanism, was known to be available.

With the possibility of storing information comes the possibility of crafting complex and seemingly nonrepetitive movement. If it is the desire of the builder of the mechanism, these movements may be arranged to mimic the movements of living organisms. This is the basis of more complex mechanical toys like the rabbit that walks about beating on a drum. (Incidentally, in 1880 a minute gold rabbit, perhaps an inch high, who also played his drum, was sold as a brooch. Not to mention a 3 inch gold caterpillar that sedately crawled its path, circa 1850.)

However engaging, these were fundamentally simple and regular movements that did not tax the designer. Mechanicians have constructed far more complex machines designed to duplicate the most intricate and coordinated movements performed by living creatures and to produce an effect of illusory life for the few minutes the mechanism operates. Why would clever, dedicated people do such a thing? Why build an automaton?

Machines That Imitate Life: a Rationale

Until modern times there was a pervasive and unchallengeable view that the bodies of human beings were not fit subjects for investigation. Death was the penalty for human dissection during the middle ages, except for rare occasions when the Church sponsored demonstrations of the corpses of criminals. Clearly, anything so sternly forbidden must have been well worth investigating; could it have been that the secret of life lay concealed in the structure of the body? There were some who took the risk, and they always found that animal and human structure were very similar. Since, in the influential and respected view of René Descartes (1596-1650), animals were machines that differed from humans chiefly in their lack of divine inspiration, it is easy to see the framework for a "mechanistic" view of living organisms. The notion held much appeal. It explained in terms that were comprehensible to the average educated man how living creatures were constructed by substituting mechanism for mystery.

Popular expositions of science from the 1890s right up to the 1940s typically depicted drawings of a person cut away to reveal bellows and pump rooms in the chest, the chemical factory in the abdomen, the telephone switchboard in the skull, the pistons and gears in the limbs, and so on.

I suggest that this conception of organisms as chains of mechanisms, and the corollary, of a god as the divine watchmaker who constructed and set them in motion, was perhaps the most influential factor leading to the construction of machines designed to imitate life. Note the variety of literature in which the attempt to create life is central to the theme: from ballads and fairy tales dating back to the beginning of language to Mary Shelley's *Frankenstein* (1818); from Offenbach's opera with the clockwork ballerina, *Tales of Hoffman* (1881), through countless science fiction works, to tales such as Shaw's *Pygmalion*. And of course there is recombinant DNA research, the leading edge of biochemical investigation at this moment where the purpose is, manifestly, to explore the mechanisms of life in living cells. The impulse is still there in us although the metaphor is different in different ages, and the mechanisms employed are dependent on available technology.

Astonishing Automata

About 1709, in Grenoble, the Edison of automata, Jacques de Vaucanson, was born. Little is known of his early life, except that he was something of a rake and a seminary dropout who disrupted affairs at the monastery by making wood and paper wings that flew about. But much is remembered of his automata, which, though they no longer exist, were the marvel of their age, the object of admiration by all gentlemen who saw them, and the envy of mechanicians ever since.

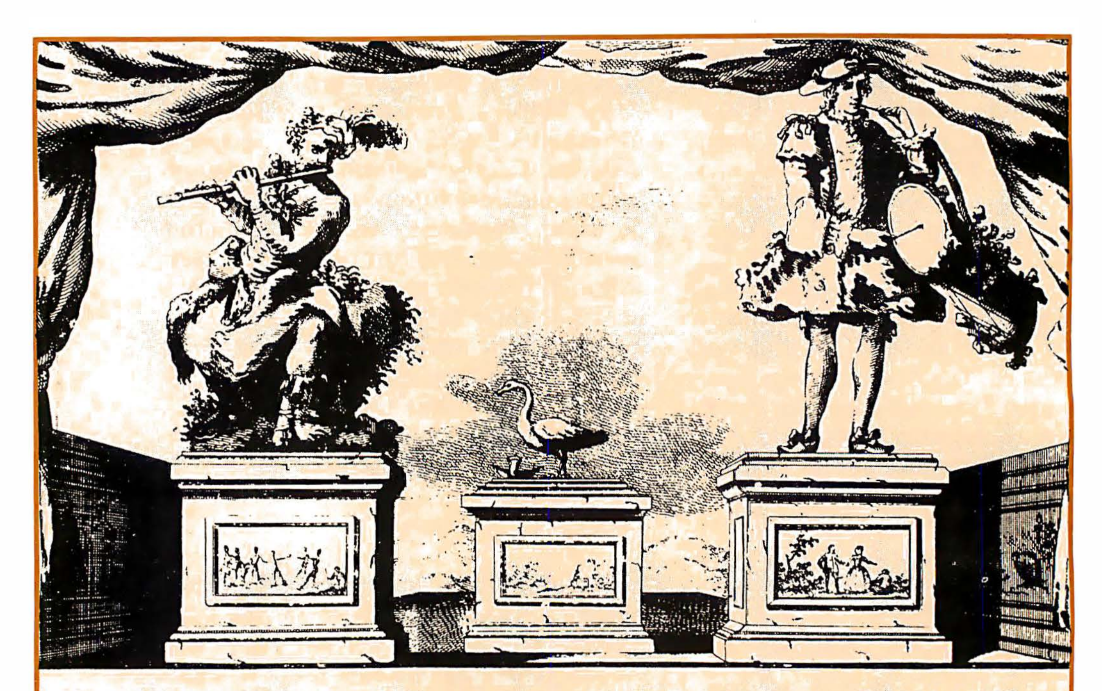
About 1709, in Grenoble, the Edison of automata, Jacques de Vaucanson, was born.

Vaucanson was not a showman, but a philosopher and inventor. He often spoke of "moving anatomy," his expression for the concept that life, especially life in lower animals, was in fact a series of undirected movements (what we would today call "reflex movements"), and that by duplicating the movements and actions of a live creature, one might succeed in duplicating the life of the creature. While such a notion seems absurd to us (it is, according to current understandings of the formation of ideas, magical, and therefore primitive) there is precedent for it from a character no less important than St Thomas Aquinas. Vaucanson had a splendid opportunity to come across St Thomas's writings, since he lived in a monastery for perhaps 15 years. Books were expensive treasures in 1709, and monasteries were the main places where collections existed. St Thomas's works would probably have been among them. In the *Summa Theologica* (Q13; Art 2; Reply obj 3; Part II) there is a passage: "Animals

show orderly behavior and are machines, as distinct from man who has been endowed with a rational soul and therefore acts by reason."

If animals are orderly machines, it might be possible to make a machine that looks and behaves like an animal. If one took special pains to reproduce vital details like respiration, digestion and excretion, etc (so runs the argument), one would then have created the next best thing to a real living animal.

Vaucanson arrived in Paris in 1735 at the age of 26 to pursue his moving anatomy con-



AVEC PERMISSION
DU MAGISTRAT DE LA VILLE,

On expofera a la vüe du Public les 3. chefs d'Oeuvres Mechaniques du Celébre Monfieur VAUCANSON, *Mémbre de l'Academie Royale des Sciences de Paris, qui confiftent en trois Figures Automates.*

SCAVOIR:

LA premiére, Un homme de Grandeur naturelle habillè en SAUVAGE qui joue Onze airs fur la Flûte traverfiére par les mêmes mouvements des Levres des doits & le fouffle de fa bouche comme l'homme vivant.

LA feconde, un homme auffi de Grandeur naturelle, habillé en BERGER PROVENCAL qui joué 20. airs differens fur le Flûtet de Provence d'une main & du Tambourin de l'autre avec toute la preçifion & perfection de méme qu'un habile joueur.

LA troifiéme un CANARD artifiçiel en Cuivre d'oré qui Bois, Mange, Croüaffe Barbote dans l'eau & fait la digeftion commo un Canard vivant.

CEs 3. Pieces qui ont fait meriter une Récompenfe a l'Autheur d'une Penfion de 8. mille & 5. cent Livres par le Roy, & qui ont engagè un grand nombre des Perfonnes de diftinction a des longs & penibles Voyages pour les voir, marque mieux leur mérite qu'un plus long detail. On Efpere que dans cette Ville un chacun fera charmè de profiter de l'occafion de les voir & qu'ils en feront la difference du nombre des bagatels, que l'on fait voir tous les jours au publique. Comme le Proprietaire doit fe trouver le 12. a Francfort il donnera pendant 8. jours a commencer ce jourd'huy 2. Répréfentations par jour a 3. & 5. heures apres midy au Poil du Miroir, l'on payera 24. Sols au premiére, 16. au fecond & 8. au troifieme place, & comme il ny a aucune tricherie dans ces beaux ouvrages l'on enfera voir l'interieur a decouvert en payant 24. Sols par perfonne, l'on vend auffi dans la méme Sale le mémoire prefentè par l'Auteur a Meffieurs de l'Academie Royale qui contient un ample detail des pieces contenües dans ces ouvrages & auffi l'Approbation des Meffieurs de l'Academie.

Les Compagnies particulieres pourront les voir a tout heure, en avertiffant d'avance & payeront 3. Livres par Perfonne etant au moin au nombre des huits.

Figure 2a: Three automata invented by Jacques de Vaucanson in the mid-18th century. Shown are a flute player, mechanical duck, and a flageolet (whistle) and drum player. The novelty of these figures caused a sensation in their time (from an 18th century engraving, courtesy Bettmann Archive).

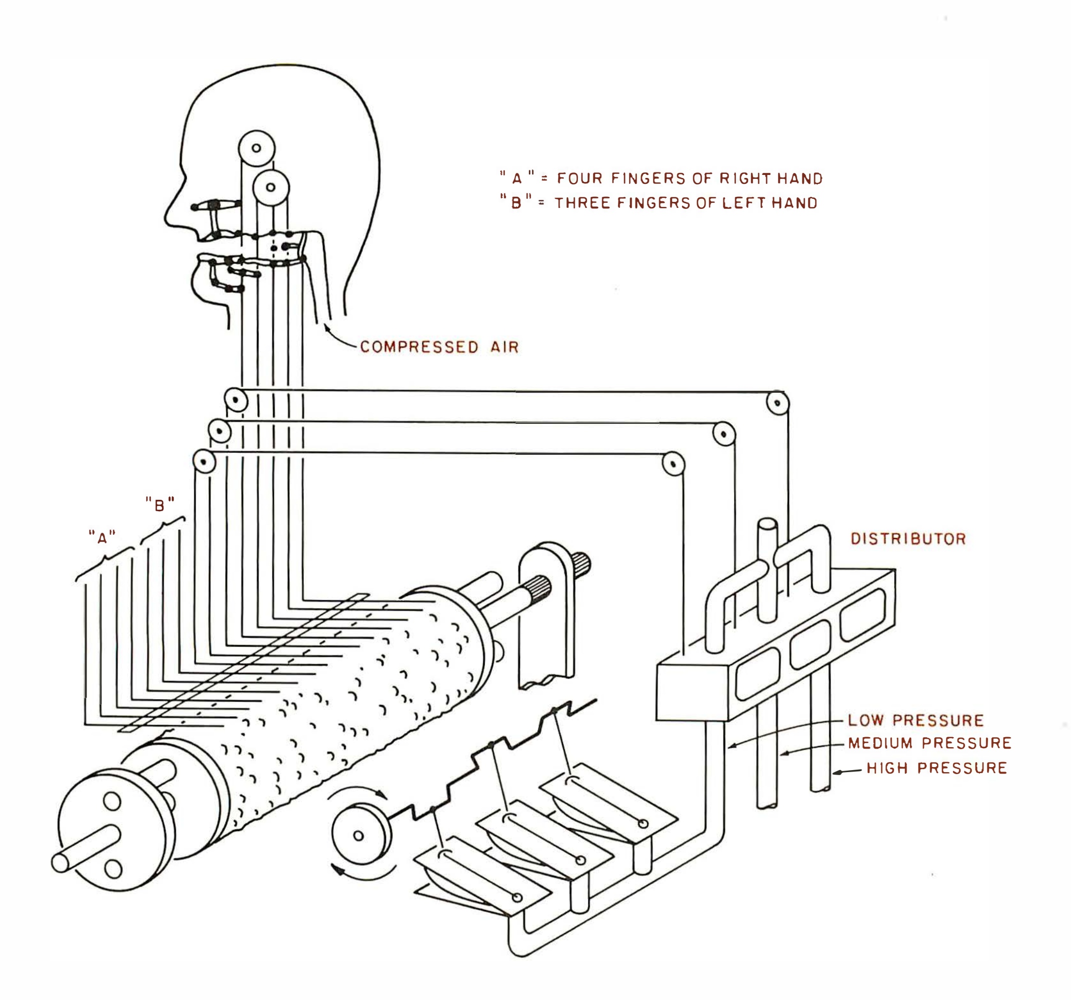


Figure 2b: Details of Vaucanson's remarkably sophisticated flute player automaton. A music box-like drum with programmed pins controlled the motion of the fingers, volume of air and shape of the mouth (made of rubber) so that the device actually played a standard flute.

cepts. He promptly ran out of money. There is documentation to show he had the idea ". . . of getting assistance by producing some machines that could excite public curiosity . . ." as a means of raising funds. He excited plenty of public curiosity, for in 1738 he simultaneously displayed three automata (see figure 2a). An automaton duck ". . . made of gilded copper who drinks, eats, quacks, splashes about on the water, and digests his food like a living duck" was one, and a pair of automata musicians who played flute and drums were the others.

The machines were life-size and were mounted on cubical pedestals about three feet on a side, which contained the bulky mechanism. They were unique and original, and they created a public sensation for 50 years. To me, the flute player seems the most remarkable mechanism of the three. De Juvigny, a friend of Vaucanson's, wrote in 1777, "At first many people would not believe that the sounds were produced by the flute the automaton was holding. These people believed that the sounds must come from a bird organ or German organ enclosed in the body of the figure. The most incredulous, however, were soon convinced that the automaton was in fact blowing the flute, that the breath coming from his lips made it play and that the movement of his fingers determined the different notes. . . The spectators were permitted to see even the innermost springs and to follow their movements." Figure 2b shows the mechanism in outline form. All that needs mention is the weight motor (not shown), and the fact that different weights were added to each bellows in the set of three to provide different pressures of air. High, medium and low pressures provided the designer with the possibility of playing notes loudly or softly in the lowest register, or of shifting the flute to a higher register by employing greater pressures. The distributor valve selected the correct pressure for a given note.

The illustration merely hints at the head mechanism, which must have been extremely complex. This description of flute playing is from the *Encyclopedia Brittanica:* "The flute is held sideways to the right of the player, who forms his lips to make an aperture and directs his breath stream across the mouth hole and onto its further edge, where it breaks up into eddies that alternate regularly above and below this edge and so excite the air column of the flute into vibration. Stability of the notes in the various registers and at different loudnesses is achieved by

"(Vaucanson's mechanical duck) is the most admirable thing imaginable, a piece of human workmanship almost passing understanding."

control of lip aperture, angle of breath impact, and breath force. The compass is three octaves. . . ." Vaucanson's complications came from his decision to use the true flute, blown from the side, and not a recorder, which is an air pipe instrument blown from one end like a pennywhistle or organ pipe. In both instruments, air column length is varied by closing the appropriate holes in the body. To some degree Vaucanson simplified his task by employing seven active fingers (instead of eight, the modern standard: or maybe his particular flute had only seven fingerholes), but he took on and overcame the challenge of providing means to produce the proper size of lip aperture and the proper angle of breath stream to mouth hole. It seems quite likely that Vaucanson used actual rubber, first seen in France in 1736, in the lip mechanism, for there is evidence (in another automaton) that he knew how to fabricate rubber.

Now, I can imagine a mechanism that would dilate and contract the aperture in a set of rubber lips, and vary somewhat the angle of a stream of air blown through the hole, but I have the considerable advantage of being able to draw on two centuries' accumulation of mechanical knowledge. Vaucanson was starting from scratch, building a mechanism never before seen, to produce a motion never before defined, to perform a task never before attempted. That he succeeded so well is astonishing; that he did it within 36 months is staggering. And remember, he employed mainly hand tools. There was no local machine shop he could call on to mill a part. We have no record of where Vaucanson learned his mechanics, but his skills were prodigious.

The combination tabor (drum) and flageolet (pennywhistle) player shown at the right in figure 2a was undoubtedly constructed along similar lines; I have not seen an explanation of its mechanism. It would have been simpler, since the flageolet is easier to play than a flute (only four or five finger holes, blown from one end), and machinery to make the right arm beat the drum would be relatively simple to figure out. It seems unlikely the two automata could have been so well synchronized that they played together.

Figure 2c: Details of Vaucanson's mechanical duck, showing the intestine-like tubing within. The duck could drink, quack and splash about, and was able to eat, digest and eliminate food (from an 18th century engraving, courtesy Bettmann Archive).

Vaucanson's Mechanical Duck

It always startles me to read things like this anonymous appreciation of Vaucanson's duck: "It is the most admirable thing imaginable, a piece of human worksmanship almost passing understanding." I try to account for the powerful attraction that constructing simulacra of lower animals held for men 200 years ago. Still, it catches me off guard to see the adulation the duck evoked. Dr G C Beireis, the fourth owner of the machine in 1785, rhapsodizes, "It was in this duck that Vaucanson's genius reached its highest point. I have still not got over my astonishment at this work. (He had seen it thirty years earlier.) One single wing contains more than 400 articulated pieces." I doubt we would feel that way today about an automated Scottie, say, but maybe ducks make better pets.

It was, from all accounts, a singular likeness to a duck, and here is what it did:

> After a light touch on a point on the base, the duck in the most natural way in the world begins to look around him, eyeing the audience with an intelligent air. His lord and master, however, apparently interprets this differently, for soon he goes off to look for something for the bird to eat. No sooner has he filled a dish with oatmeal porridge than our famished friend plunges his beak deep into it, showing his satisfaction by some characteristic movements of his tail. The

way in which he takes the porridge and swallows it greedily is extraordinarily true to life. In next to no time the basin has been half emptied, although on several occasions the bird, as if alarmed by some unfamiliar noises, has raised his head and glanced curiously around him.

After this, satisfied with his frugal meal, he stands up and begins to flap his wings and to stretch himself while expressing his gratitude by several contented quacks. But most astonishing of all are the contractions of the bird's body clearly showing that his stomach is a little upset by this rapid meal and the effects of a painful digestion become obvious. However, the brave bird holds out, and after a few moments we are convinced in the most concrete manner that he has overcome his internal difficulties. The truth is that the smell which now spreads through the room becomes almost unbearable. We wish to express to the artist inventor the pleasure which his demonstration gave to us. (From Chapuis' book, *Automata: Historical and Technical Study*, see detailed bibliography in part 3 of this article.)

Something here for everyone, isn't there? Passion, satisfaction, and a dash of slapstick. The mechanicians in the audience were dazzled by Vaucanson's skill in building a duck that could swivel its neck in every direction while sitting or standing; this does suggest some remarkable techniques for managing the pushwires ascending the legs, maybe even some internal mechanisms within the body.

Probably written by Vaucanson and certainly based on data only he could have provided, the following passage from an article in a 1777 dictionary of science shows how proud he was of the internal mechanisms that caused grain to be "... digested as in real animals by dissolution and not by (grinding) . . . the inventor does not set this up as a perfect digestive system capable of manufacturing blood and nourishing juices to support the animal, and it would be unfair to reproach him with this shortcoming." But it is clear how well he knew the 18th century idea that blood comes from food, and he implies he was trying to follow it. Indeed, in some accounts the body was covered by latticework so the interior mechanisms could be viewed as they did their job. Vaucanson had good reason to be proud, for the body contained his new invention, the rubber tube. Any machine capable of making that kind of smell had to be alive!

One wonders what the "...chemical laboratory where the principal part of the food could be decomposed..." mentioned in the article might refer to. It may have been that his rubber tube intestine actually contained some chemicals or enzymes that attacked the starch in oat porridge, causing it "...to leave the body in markedly changed form." But there was hardly time enough in a performance of a few minutes to convert anything. More likely the operator between performances drained the stomach of its contents and loaded the nether-part of the intestine with the imitation duck dung that so impressed audiences.

The duck and the two musicians probably made a good deal of money for Vaucanson, but because it was necessary to transport them to other capitals of Europe for further exhibition he sold them all in 1743 to showmen who took them to England, Russia, and finally to Germany. In St Petersburg in 1782 the third owners tinkered with the mechanisms, interchanging parts so they would break if anyone else tried to show them. Dr Beireis had this partly repaired, but when Goethe viewed the duck in 1805, he found, "Vaucanson's automata were paralyzed. The duck had lost its feathers and, reduced to a skeleton, would still bravely eat its oats, but could no longer digest them." The duck was 108 years old when Rechsteiner, a skilled mechanician, was hired to repair it. It was exhibited in Italy in 1844 and in London two years later. After that it dropped out of sight. Some photographs turned up in the early 1950s, evidently left by the former curator of the Paris Museum of Arts and Crafts. They are glass plate negatives that probably date from before 1900. The skeleton they reveal, together with the appearance of the mechanism, strongly suggests the wreckage of Vaucanson's duck, as they were labelled. The plates were said to be from Dresden, and if the duck survived World War II, one hopes it is in a dry attic. The musicians were lost from sight sometime around 1800. None of the imitations of Vaucanson's automata, including mekaniker Rechsteiner's duplicate duck, now survives. These wondrous mechanisms are altogether lost.

Vaucanson himself seems to have prospered (he was a member of the Academy of Science in 1777) and continued inventing. In 1741 he devised the system of punched cards that controlled looms in the Jacquard tapestry factory. This is generally considered to be the first digital number storage and readout system. In 1760 he invented the

Satisfied with his frugal meal, the mechanical duck stands up and begins to flap his wings and to stretch himself while expressing his gratitude with several contented quacks.

modern metal-cutting lathe, with a shaped guideway to prevent chatter and twisting of the tool.

Mechanism of the Automata

While relatively simple to explain and easy to grasp when explained, Vaucanson's machines really are very sophisticated in performance and embody concepts easily 100 years ahead of their time. The weight-motor is a heavy weight suspended from a rope wrapped around a drum windlass, which, while slowly falling, drives a gear-train (speed controlled by a governor). These gears slowly turn a cam-drum, the master controller "memory" mechanism, one rotation of which equals one performance of the automaton. This drum, perhaps the diameter of a small keg and three feet long, has on its surface an array of rows of studs of some sort, nails or wooden knobs. Cam-followers, some sort of spring loaded levers, ride on the drum surface, one for each row (circle) of studs in the array, and each cam-follower is for a moment pushed out of place if a stud rotates by to push on it.

There are as many circles of studs on the drum as there are functions of the automaton to be controlled, and the cam-follower unique to that circle of studs does the controlling. Thus, one row, say, controls the dilation and contraction mechanism of the lips, and another row might manage the movements of the first finger, left hand, and so on. There would be about 12 functions to be controlled, so about 12 rows or circles of studs are on the drum. It is rather like a giant music box movement, except that instead of steel needles being plucked, cam-followers are displaced, and with displacement each follower pulls on a flexible cable which is linked by its own pulley system to the finger, lip, or valve that is unique to it. In some cases, like the lip control mechanism, the requirement to produce music is for smooth variation from one size to another, so the row of studs for that function is replaced by a smoothly varying curve, a cam. In other cases, the fingering mechanism, a finger either does or does not cover a flute hole. This is digital control (the word comes from counting on the fingers); the former is analog, meaning that a little movement here causes a proportional movement there.

When it is all put together and regulated carefully, the machine will play the flute using wind pressures as selected by the distributor valve. For the sake of impressive appearance, the machine is covered with a wooden framework in human shape and is clothed, but it would do its job bare. However, it would look like a machine and not a person.

The tabor and flageolet player is similar, but probably only two levels of wind were employed, and the fingering is simpler, probably four fingers.

The duck was essentially a giant version of the mechanism that operated the bird figures described earlier but with many more, and more complex, movements. While it is possible that some weight sensitive area was built into the pedestal so that the duck started to gobble the food only when a plate was placed before it, it seems much more likely that the operator carefully memorized the duck's movements (which, of course, are identical every time) and returned with the plate at just the right moment. Otherwise the bird would have been gulping down thin air.

If they still existed, these machines would provide an intriguing catalog of early 18th century movements, probably including some that Vaucanson devised for special purposes that would not be rediscovered for 75 years or more. But, as computers, the machines were incredible. Here, 240 years ago, was a digital and analog computer preprogrammed with perhaps 300 to 500 bytes of read only memory, each byte 10 or 12 bits wide. Vaucanson appears to be the first person to have seen the need for synchronous control of multiple functions (how else could you play a flute except by regulating breath angle and pressure while simultaneously fingering the proper notes?) as well as the first who saw the *possibility* of designing mechanisms to effect such control. That he used the music box spindle approach to his problem is not to his discredit, for that mechanism was known to function reliably over long periods while undergoing little wear. His incorporation of music box memory devices into an array on a single drum (the master controller) enabled him to produce some remarkable results. He could control a variety of simultaneous, interdependent functions because they were all driven by the same "clock." This was parallel data processing, in relatively small chunks, to be sure, but parallel beyond doubt. The likes of it were not seen again in mechanics until the player piano with its paper tape. It is not so very different from the way the central nervous system deals with data in many parallel channels simultaneously.

But why is this surprising? Jacques de Vaucanson was attempting to create life. It was his genius to approach the task in the manner of living things.■

Note:

A complete bibliography for this part of "Antique Mechanical Computers" will appear with "Part 3: Human and Machine Action and the Torres Chess Automaton" in September 1978 BYTE.

The Z-80 in Parallel

Bob Loewer
Micro Diversions Inc
7900 Westpark Dr
Suite 308
McLean VA 22101

Many design engineers have introduced various types of parallel processing into systems in order to achieve higher throughput rates. Almost without exception though, these applications have been limited to medium and large scale computers due to price and complexity.

In the past two years, microprocessors have reached a level of sophistication which makes them candidates for parallel processing systems. Such systems could conceivably offer minicomputer performance at microcomputer cost. This article is an investigation of that idea.

Figure 1: The author's parallel Z-80 system. Both processors work independently, each supported by 32 K bytes of programmable memory. The processors are linked by 32 K bytes of shared programmable memory. The shared memory, addressable by either processor as the upper 32 K, has its own address and data buses. Shared memory conflicts are resolved by the arbiter circuit shown in figure 2a.

The Z-80

The Z-80 microprocessor, manufactured by Zilog, is a third generation LSI device which offers full software compatibility with the 8080 processor. Upgraded features provided by the Z-80 include: two sets of exchangeable registers, indexing, a full range instruction set (including register or memory bit operations), eleven addressing modes, a nonmaskable interrupt, dynamic memory refresh address generation, and an interrupt register to provide a high speed vectored interrupt response to any location in memory.

The Z-80's minimum number of control bus signals makes it easy to interface in multiple processor configurations.

System Layout

My design consists largely of two Z-80 microprocessors (processor X and processor Y) operating independently, each supported by 32 K bytes of programmable memory (see figure 1). The processors are indirectly linked by 32 K bytes of common memory, making a system total of 96 K bytes. The shared memory, addressable by either processor as the upper 32 K, has its own address and data buses. Data or address signals are gated onto their respective bus when (1) either processor performs an operation involving a read or write against the shared memory, or (2) either processor attempts an op code fetch from the shared memory, or (3) machine instructions combine (1) and (2).

Shared memory bus conflicts are resolved by the arbiter (see figure 2a). Since the processors use opposite phases of the clock, requests for bus access can never be initiated at exactly the same time. However, depending upon the instruction sequences being executed, bus request conflicts can occur. This problem, summarized in table 3, has been carefully examined and is represented by figure 3b. It illustrates what is assumed to

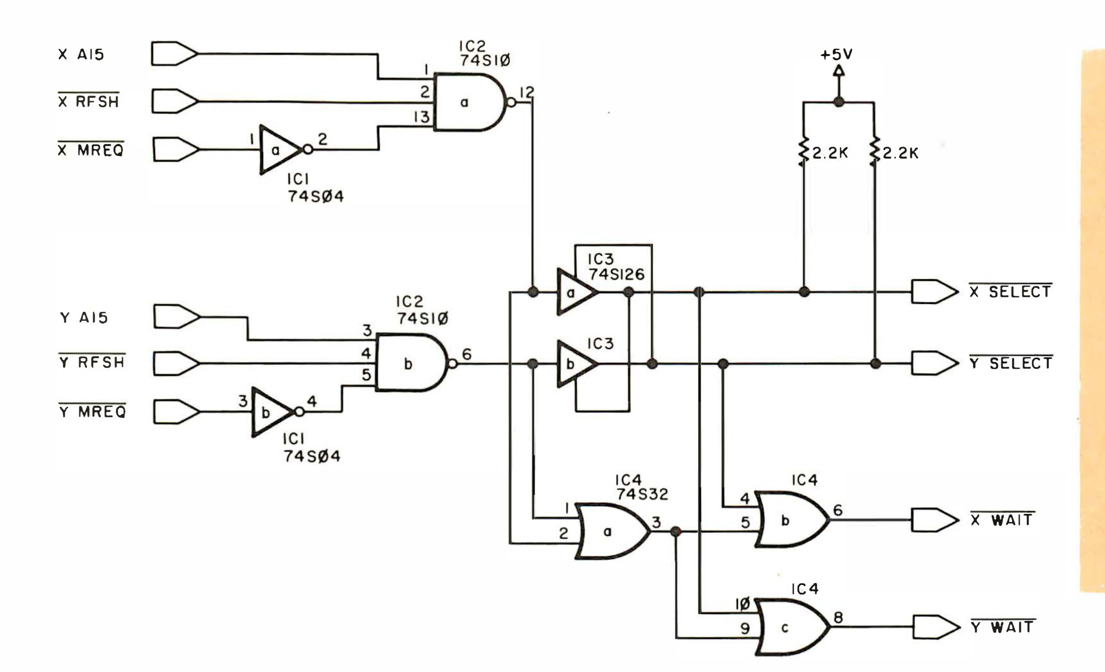


Figure 2a: The shared memory arbiter. This circuit resolves conflicts between the two processors if both attempt to gain simultaneous access to the shared memory bus. For example, a request from processor X (XMREQ low) will cause IC3a to drive the XSELECT line low and will also disable IC3b. Processor Y will be locked out during X's memory request. If Y makes a memory request while locked out, the output of IC4a will go low, activating the YWAIT line.

About the Author

Bob Loewer is an employee of the Telenet Communications Corporation and a graduate student at the University of Maryland at College Park. He is cofounder of Micro Diversions Inc, a company involved with microcomputers and microcomputer education. This article describes Bob's early research on parallel microprocessor systems.

be the worst possible case of bus conflict: both processors simultaneously executing shared memory read or write instructions from the shared memory. Of course, one cannot predict when each processor will attempt to access the shared memory, so all possible interprocessor state relationships have been investigated.

The basic memory read or write instruction has seven "T" cycles (T is defined as the duration of one clock period). The T states and their functions are:

```
M1,T1                       |
M1,T2                       |  Op code fetch
M1,T3  { Instruction        |
M1,T4  { decoding           |
M2,T1  )
M2,T2  }  Memory read or write operation
M2,T3  )
```

The M cycles are machine cycles. Table 3 shows the seven interprocessor T state alignments: M1,T1 active for one processor when states M1,T1 thru M2,T3 for the other are active. Figure 3b illustrates an example of the processor request signals and signals from the conflict arbitration logic. Note that after a very short period (maximum of seven clock cycles) the arbiter synchronizes and thereby provides complete cooperation between the two processors' fetch and execution cycles by putting one of the processors into one or two wait states. Further, in the seven possible interprocessor T state relationships, there are two in which opposing shared memory access request signals are synchronized, in which case the arbiter does nothing. This means that, regardless of the processors' instruction

Number	Type	+5 V	GND
IC1	74S04	14	7
IC2	74S10	14	7
IC3	74S126	14	7
IC4	74S32	14	7
IC5	74125	14	7
IC6	74125	14	7
IC7	74125	14	7
IC8	74125	14	7
IC9	74125	14	7
IC10	74125	14	7
IC11	74125	14	7
IC12	74125	14	7
IC13	7432	14	7
IC14	7408	14	7
IC15	74S157	16	8
IC16	74S157	16	8
IC17	74S157	16	8
IC18	74S157	16	8

Table 1: Power wiring table for figures 2a and 2b.

Figure 2b: Control circuitry for the shared memory parallel Z-80 system. The respective processor data buses and the shared memory data bus are shown at the top. The shared memory address bus is at the right. The shared memory arbiter is shown in the center (see figure 2a for a detailed schematic). This circuit works on a first come, first served basis to resolve all conflicts between the two processors.

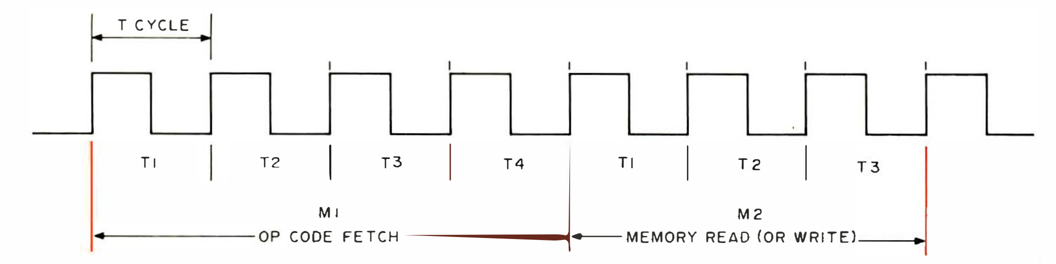


Figure 3a: The basic Z-80 memory read or write cycle. Clock periods are referred to as T cycles and the basic operations are referred to as M (for machine) cycles. The first machine cycle of any instruction is a fetch cycle (M1). Subsequent M cycles move data to or from the memory.

sequences, 86 percent of the time the system is at most one wait state away from synchronization. Thereafter, both processors can execute read and write instructions from the shared memory at 100 percent processor utilization, assuming the instruction synchronization is not lost.

Certainly opposing software will not consist solely of instructions which offer no bus interference. But it is clear that the most efficient method of solving the shared memory bus conflict problem is the one that will achieve short term interprocessor synchronization whenever possible.

Arbitration Logic

Each processor provides signals to the arbiter which identify a valid shared memory access request. IC2a and IC2b receive RFSH, MREQ, and A15 (the high order address bit signal) from their respective processors. MREQ indicates that a memory read or write operation is underway: either A15 line going high identifies the shared memory as the object of the request; and the RFSH lines insure that the dynamic memory refresh strobe from one processor will not interfere with the shared memory access request of the other.

IC3a and IC3b provide an opposing grant or deny shared memory bus access proviso that is strictly first come, first served. A request from, say, processor X will cause IC3a to drive XSELECT low, and coincidentally disable IC3b. Processor Y will be locked out for the length of processor X's memory request. Now suppose processor Y *does* make a request for bus access when processor X is using the bus. This condition will force IC4a to its low state, activating the YWAIT line. The wait signal will continue until processor X concludes its memory access. Under no circumstances, however, will processor Y be forced into more than one wait state for this processor X access. When XMREQ goes high, XSELECT follows

Continued on page 174

Beginning Event	Finishing Event	Stipulation	Delay Before Occurrence (ns)
XA15 high XRFSH high XMREQ low	to XSELECT low	YSELECT high	28
XA15 high XRFSH high XMREQ low	to XSELECT low	YSELECT low	25 after YSELECT goes high
YA15 high YRFSH high YMREQ low	to YSELECT low	XSELECT high	28
YA15 high YRFSH high YMREQ low	to YSELECT low	XSELECT low	25 after XSELECT goes high
XA15 high XRFSH high XMREQ low	to XWAIT low	YSELECT low	53
YA15 high YRFSH high YMREQ low	To YWAIT low	XSELECT low	53
XSELECT high	to YWAIT high	YSELECT low	22
YSELECT high	to YWAIT high	XSELECT low	22

Table 2: Timing considerations in the arbiter circuitry. The arbiter takes a finite amount of time for its logic circuits to effect the changes shown. The corresponding delays are shown at the right.

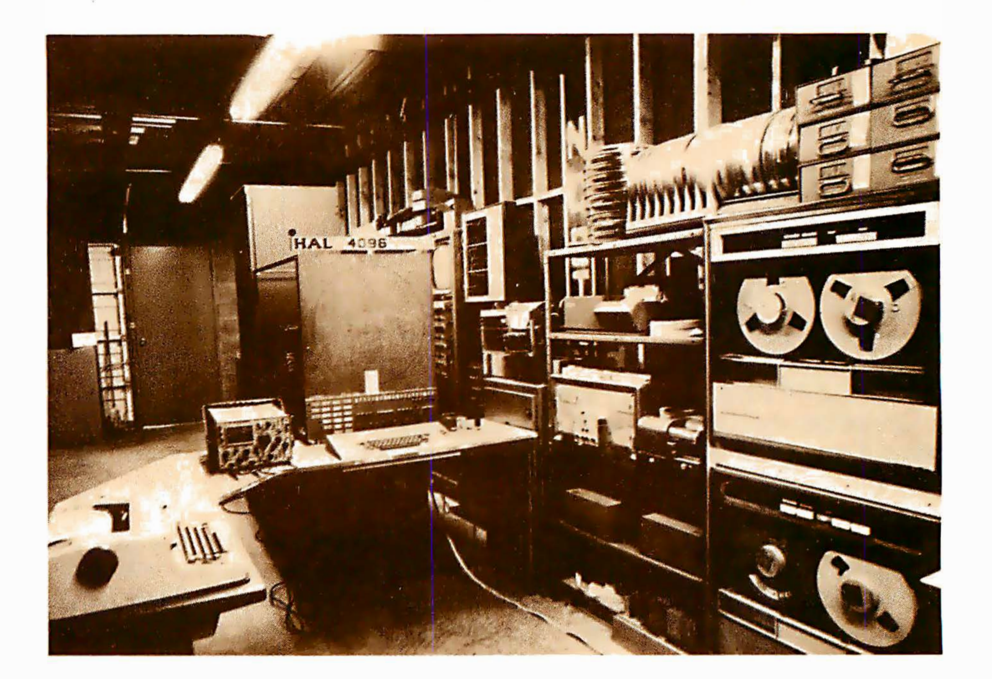


Photo 1: Hal Chamberlin's home built HAL-4096 computer system, built in 1972. This system, which is still in service handling IO for an IMP-16 microcomputer system, features TTL logic, a 16 bit word length, 16 registers, 4 K bytes of magnetic core memory (a surplus IBM 1620), and priority interrupt.

The First Ten Years of Amateur Computing

Sol Libes
President, Amateur Computer Group of New Jersey
995 Chimney Ridge
Springfield NJ 07081

If one could find a specific date for the birth of personal computing, it would be May 5 1966.

Most people I meet are under the mistaken notion that personal computing started only two or three years ago, with the introduction of the Altair 8800 by MITS. Nothing could be further from the truth. In fact, the amateur computing hobby was then almost ten years old.

I therefore decided to write this article to set the record straight, give credit to the early pioneers in this hobby and shed some light on the early history of microprocessors.

If one could find a specific date for the birth of personal computing, it would be May 5 1966. For it was on that date that Steven B Gray founded the Amateur Computer Society and began publishing a quarterly called the *ACS Newsletter*.

The newsletter exchanged information on where to get surplus computer gear, how to build not too complicated circuits, where to get integrated circuits, tips, experiences and where to get help. By the end of 1966, the Society reported that it had over 70 members.

1966 also saw the publication of the first books on how to build a home computer. Typical was *We Built Our Own Computers* by A B Bolt and published by Cambridge University Press.

In January 1968, a survey in the *ACS Newsletter* reported that two amateurs had their home built systems up and running and that many others were actively working on their systems. The survey indicated that programmable memory sizes ranged from 4 to 8 K with some as high as 20 K, all magnetic core of course. Teletypes and Flexowriters were popular for IO. Clock speeds ranged from 500 kHz to 1 MHz, with the average 500 kHz. Most used discrete transistors, and a few reported using those new and hard to come by RTL integrated circuits. Instruction sets were small, ranging from 11 to 34 instructions. Word sizes were from four to 32 bits, with 12 bits the typical number. Registers ranged from two to 11, with three most common. Most reported that they had been working on their machines for about two years.

The April 1968 issue of *Popular Mechanics* reported on ECHO IV (Electronic Computing Home Operator), a home built computer constructed by Jim Sutherland. It had four registers, used a 4 bit word, had 8 K bytes of core memory, 18 instructions and a clock speed of 160 kHz.

In December 1968 Don Tarbell (now

Two Bytes Are Better Than One

TMS 9900
16BIT
MICROCOMPUTER
SS-16

SUPER STARTER SERIES

COLOR VIDEO BOARD

FLOPPY DISK DRIVES

4800 BAUD DIGITAL CASSETTE

TECHNICO

THE FULL POWER OF THE **16-BIT TMS 9900 MICROPROCESSOR** IS NOW AVAILABLE WITH THE UNIQUE COMBINATION OF RELIABLE HARDWARD AND FAST, EASY TO USE SOFTWARE IN THE **TECHNICO SS-16.** WITH MINICOMPUTER PERFORMANCE THE **TECHNICO 16-BIT MICROCOMPUTERS** ARE AVAILABLE FROM THE **SINGLE BOARD SUPER STARTER SYSTEM AT UNDER $400** TO THE FULL **SS-16 WITH UP TO 65K BYTES OF MEMORY, MINI-FLOPPY OR FULL FLOPPY DISKS, A 4800 BAUD DIGITAL CASSETTE, 64 COLOR VIDEO BOARD OPTION, RS232 AND 20 MA CURRENT LOOP** ALL COMBINED WITH ONE OF THE INDUSTRY'S FASTEST BASICS AND A FULL ASSEMBLER, EDITOR, LINKING LOADER PACKAGE. SYSTEMS ARE AVAILABLE COMPLETELY ASSEMBLED AND TESTED OR IN UNASSEMBLED **TEC-KIT™** FORM. EXPLICIT MANUAL INCLUDED OR AVAILABLE SEPARATELY AT $35. TO LEARN MORE...JUST TEAR OFF A PIECE OF THIS AD AND RETURN TO TECHNICO OR CALL OUR HOTLINE 1-800/638-2893 OR YOUR LOCAL DEALER.

EUROPEAN MODELS AVAILABLE THROUGH TECHNICO INTERNATIONAL



9130 RED BRANCH RD.
COLUMBIA, MD. 21045
PHONE 301-596-4100

DOMESTIC SALES



2442 N. LEXINGTON ST.
ARLINGTON, VA. 22207
PHONE 703-538-4000
TELEX: 64100 SOLIDSTA

SALES OUTSIDE CONTINENTAL U.S.

Circle 372 on inquiry card.

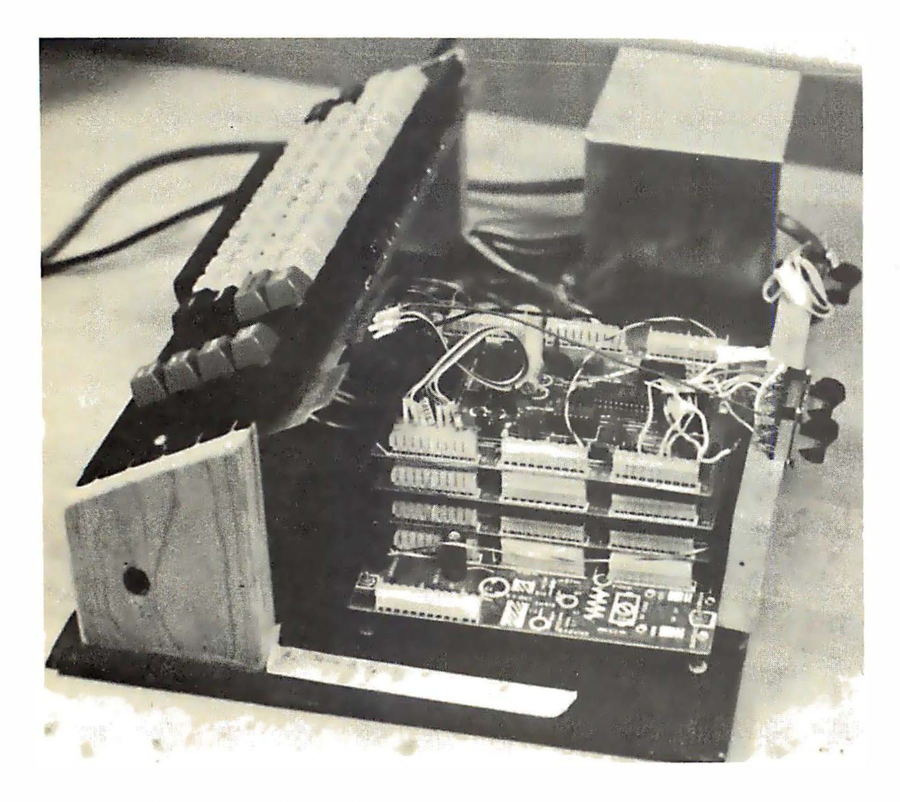


Photo 2: The author's TVT-1, designed by Don Lancaster and built in late 1973. Intended only as a TV typewriter, it was interfaced to a modem and used with an IBM timesharing system.

known for his high speed tape cassette interface) reported on his home built computer in the *ACS Newsletter.* It had a 4 bit word size, four registers, 10 kHz clock and was constructed using RTL integrated circuit logic. He used a Teletype for IO.

The first computer kit was introduced in 1971. It featured 52 TTL integrated circuits, a 32 by 8 bit programmable memory, and 15 instructions for $503.

In 1967, Dave Digby ran an ad in *CQ* magazine offering a computer kit. It was advertised as featuring RTL logic, four registers, a 512 to 1024 byte delay line memory, and serial input and output. The price was $1000. As far as I know, he never delivered any units.

Most early builders constructed copies of the Digital Equipment Corporation's PDP-8 minicomputer with their own modifications. In the surplus area, 1000 Minutemen I missile guidance processors became available in 1971.

The Kenback-1 computer featured a 1 K byte MOS shift register memory made by a small, young manufacturer called Intel.

1971 also saw the introduction of the first computer kit. It was part of the National Radio Institute's course on computer electronics. It used 52 TTL integrated circuits, had a 32 by 8 bit integrated circuit memory, 15 instructions and an operator's panel, and it sold for $503. Louis E Frenzel, then of NRI and now at Heathkit, was the designer.

In late 1971, the Kenback Corporation introduced the Kenback-1 computer for $750. It was intended primarily for educational use. It had a 1 K byte MOS shift register memory made by a small, young integrated circuit manufacturer called Intel. It also had three registers, an 8 bit word size, 65 instructions, operator's panel, and an audio cassette for program storage.

The December 1971 issue of *Computers and Automation* described five home built computer systems. And by the end of the year 1971, there were reported to be 195 members in the Amateur Computer Society.

In 1972 things continued to pick up. In June Don Tarbell reported that he had written an editor program for his new home built system and was working on an assembler program. His system used an 8 bit word, 16 registers, and 4 K bytes of core memory.

Early 1972 saw the introduction of the 8008 microprocessor, by Intel, the opening of a number of used computer equipment stores, large price drops in TTL logic and the availability of the 1101 programmable memory at low cost. All of this proved to be a tremendous stimulus for amateur computer experimenters.

In the September 1972 issue of the *ACS Newsletter* Hal Chamberlin reported on his home built HAL-4096. This 16 bit machine utilized surplus IBM 1620 core memories. Hal furnished a complete set of construction plans for $2. The system had 16 registers, priority interrupt, Selectric and paper tape IO, and many other very advanced features.

The September 14 1972 issue of *Electronic Design* carried an article on how to build a circuit which would display 1024 ASCII characters on a TV set.

In 1973 amateur computing advanced in several areas. In May, the EPD company advertised the System One computer kit for $695. It had 1 K bytes of memory with expansion to 8 K and contained 82 integrated circuits. It had 57 instructions encoded in a diode matrix read only memory.

The September 1973 issue of *Radio Electronics* published Don Lancaster's plans for the construction of the TVT-1. Although intended as a TV typewriter, many enterprising experimenters interfaced it to modems and home built computers.

In late 1973, the Scelbi Computer Consulting Company introduced the first computer kit using a microprocessor. The kit was called the Scelbi-8H and it sold for $565. It used the Intel 8008 and had

```
200  TURNOFF RELAY 6:DELAY
     300:REM STOP ARM, WAIT
     300 MS
210  TURNON LITE 4:REM
     SIGNAL ARM IS IN PLACE
220  DO:REM PULSE STEPPER
     UNTIL CAM IN PLACE
230  TURNON RELAY 0:DELAY 5:
     TURNOFF RELAY 0
240  DELAY 100-N:N=N+1:REM 1
     DUTY CYCLE ON STEPPER:
     COUNT PULSES
250  UNTIL SENSE 4=0:REM
     ACTIVITIES SWITCH
260  PRINT "CAM IS IN
     POSITION AFTER";N;"
     STEPS"
```

16 TTL sense inputs

16 TTL sense inputs

32 TTL outputs to relays, LEDs, ICs, etc.

Cassette interface; motor control, data output, data input

2 serial I/O ports, 1 with 20MA current loop

Power supply input

Expansion bus

Sockets for up to 16k of on-board RAM

4k dynamic RAM

Composite video output, 64x16 display

Z-80 MPU

1 parallel port for data transmission

1 input port for keyboard

8 relay outputs for motors, solenoids, etc.

8 user definable indicator lites

ZIBL™ in PROM

Lite port displays an 8-bit word

Programming slots for 2 TMS 2716s; stores user's programs

4 3/4-amp reed relays

4 general purpose relays, 5 amp at 115 VAC

Dynabyte's new Basic Controller™: Check out its capabilities and imagine your applications

The Basic Controller™ is a powerful, versatile and easy to use single board microcomputer system designed for control applications.

It is heavily into control I/O: relays, flags and sense inputs. What makes controlling these I/Os (and the external devices they control) so easy is our ZIBL™ (Z-80 Industrial Basic Language). It is a superset of NIBL, National Semiconductor's control BASIC, and was written by us specifically for control applications.

We've divided the control world into six categories: sense inputs, flag outputs, lites, relays, A/Ds and D/As. ZIBL implements 64 channels of each in such a way that you need not know anything more about them than their names.

In ZIBL it is valid to say:

100 IF TIME = 053010 AND SENSE (18) = 0 TURNON RELAY 5

Simple, isn't it!

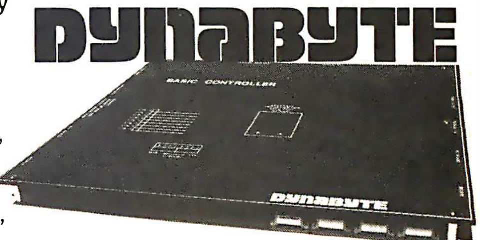
Some but not all of the Basic Controller's mouth watering features include:

- File structures that allow multiple programs written in ZIBL to reside concurrently in RAM. Each program may be individually LOADed, RENAMEd, or RUN. Any program may access another program as though it were a subroutine, while still retaining its own line numbers and variables.
- Complete communication versatility. LISTing, PRINTing and INPUTing may be done to or from any serial or parallel I/O channel or the self-contained CRT I/O.
- Single key SAVE or LOAD to and from cassette.
- Single key SAVE to EPROM. No worry about PROM addressing or programming routines, it is handled by ZIBL — automatically — even if there are other programs already in PROM.
- ZIBL in ROM: TURNON, TURNOFF, DELAY, TIME, REM, IF THEN, DO UNTIL, GOTO, GOSUB, @(exp), TRACE MODE, LINK, READ, DATA, DIR, RND(x,y), strings, triple precision integer arithmetic, plus the usual statements.
- Onboard: Z-80 MPU, 32 flags, 32 sense, 8 relays, 8 lites, 2 serial, 1 parallel, cassette I/O, 64x16 video, keyboard port, two 2716 sockets with programming capability, up to 16k on-board RAM, up to 48k off-board RAM, real time clock, vectored interrupts, Lite Port on board, a kitchen sink, and an Expansion Bus.

$750 assembled, tested, warranted 1 year. You add power supply, keyboard and monitor. Available now — see your computer retailer.

1005 Elwell Ct., Palo Alto, CA 94303 (415) 965-1010

DYNABYTE



Circle 110 on inquiry card.

1 K bytes of integrated circuit programmable memory. It was expandable to 16 K bytes of programmable memory ($2760) and had options such as cassette IO, ASCII keyboard input, oscilloscope output and serial IO.

In 1973, Digital Equipment Corporation offered the PDP-8A with 1 K words of 12 bit programmable memory for $875. Also in 1973, a small publishing house catering to computer and digital electronics hobbyists began publishing with a book on wire wrap construction techniques. It was called M P Publishing Company and was a part time activity of Carl Helmers (who later began a monthly called *Experimenters' Computer System* which after five issues was transformed into BYTE in 1975).

1974 marked a year of substantial increase in amateur computing. In July, *Radio-Electronics* magazine carried a construction article by Jonathan Titus on building the Mark-8 processor, which used the Intel 8008 microprocessor. It is estimated that over 500 of these units were built by avid experimenters.

In October, Southwest Technical Products Company (SwTPC) introduced the TVT-II kit for $180 and an ASCII keyboard kit for $40.

In September, Hal Singer started the *Micro-8 Newsletter* to exchange information among hundreds of experimenters who were building the Mark-8 unit.

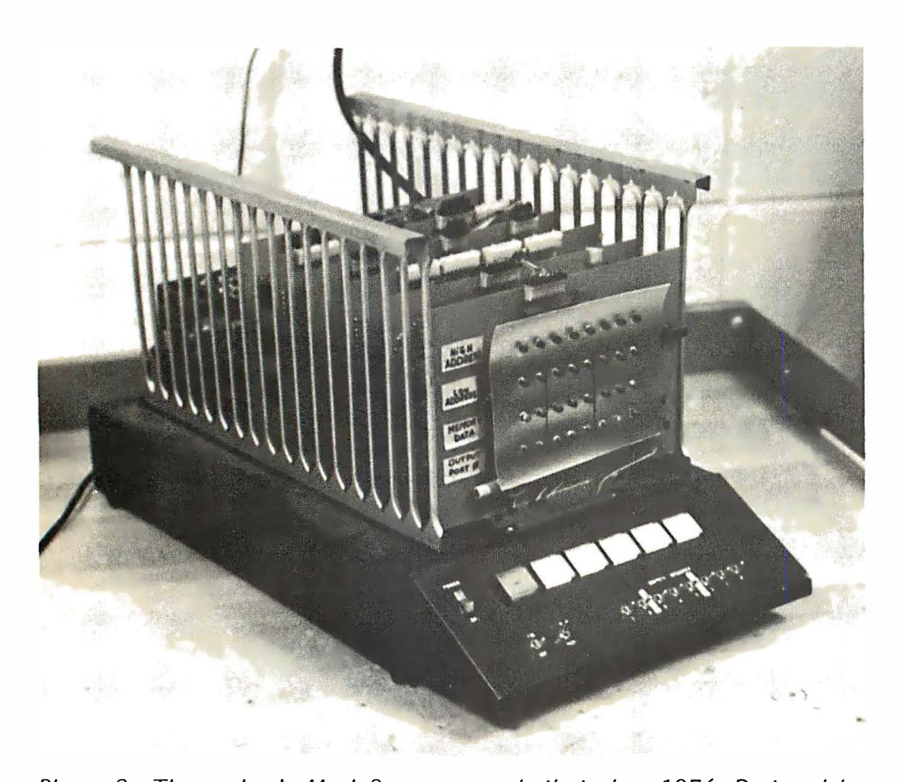


Photo 3: The author's Mark-8 processor, built in late 1974. Designed by Jonathan Titus, it uses the Intel 8008 microprocessor and has 1 K bytes of programmable memory.

In November 1974, Hal Chamberlin and some associates began another very popular but short-lived magazine called *The Computer Hobbyist.*

1975 was the year that personal computing exploded. It began, in January, when *Popular Electronics* carried an article on the Altair 8800 microcomputer by MITS. First deliveries were in April 1975. The kit sold for $375 and included 1 K bytes of programmable memory, but no IO. MITS claims that by the end of 1976 they had sold over 10,000 Altair 8800s (80% to hobbyists).

In April, the first computer club held its meeting. Started by Bob Reiling and Gordon French, and calling itself The Homebrew Computer Club, it met in Menlo Park CA. One month later the Amateur Computer Group of New Jersey was formed.

In the fall of 1975, MITS released its 4 K and 8 K BASIC interpreters, SwTPC introduced their 6800 based microcomputer, and the first decade of amateur computing was complete. Since then, the field as we know it today has rapidly matured and expanded.

Some Microprocessor History

Intel Corporation must be credited with developing the microprocessor, the single chip integrated circuit which performs the basic functions of a central processing unit.

In 1969, a Japanese company, Busicom, contracted with Intel to develop a chip set for a printer-calculator. It used a 4 bit data bus and consisted of four integrated circuits in a set: a processor, read only memory with IO, programmable memory with IO, and a shift register type memory. Busicom permitted Intel to market the chip set for noncalculator applications, and the first generation of microprocessors was born.

The processor chip was designated the 4004, and it sold for $200. It came in an 18 pin dual in line package (DIP) and would interface only with the other chips in the family. Programs had to be stored in the erasable read only memory. Data and address information was multiplexed on the 4 bit bus. Since program could only be executed out of read only memory, and since progammable memory was used only to store data, debugging software proved to be difficult. Further, a great deal of support logic was required.

At nearly the same time, Datapoint, a manufacturer of intelligent terminals, contracted with Intel and Texas Instruments to produce a true processor on a

An INFO 2000 DISK SYSTEM gives you a lot less than you expected:

Less Cost

The DISCOMEM Controller board costs us less to manufacture. So your complete INFO 2000 Disk System costs you less – at least $400 less than comperable disk systems.

Less Hardware

Only three S-100 boards are needed to create a complete, high-performance disk-based microcomputer system–the DISCOMEM Controller Board, a 32K memory board, and any 8080, 8085 or Z80 CPU board. You don't need extra interface or EPROM boards since DISCOMEM contains 2 serial ports, 3 parallel ports and provision for 7K of EPROM and 1K of RAM.

LessTime

The INFO 2000 Disk System is incredibly fast! Disk seek times are up to 8 times faster than with other drives. A full disk-to-disk copy and verification takes well under a minute. Formatting and verifying a new diskette takes less than half a minute. Reloading CP/M* from diskette takes a fraction of a second.

Less Space

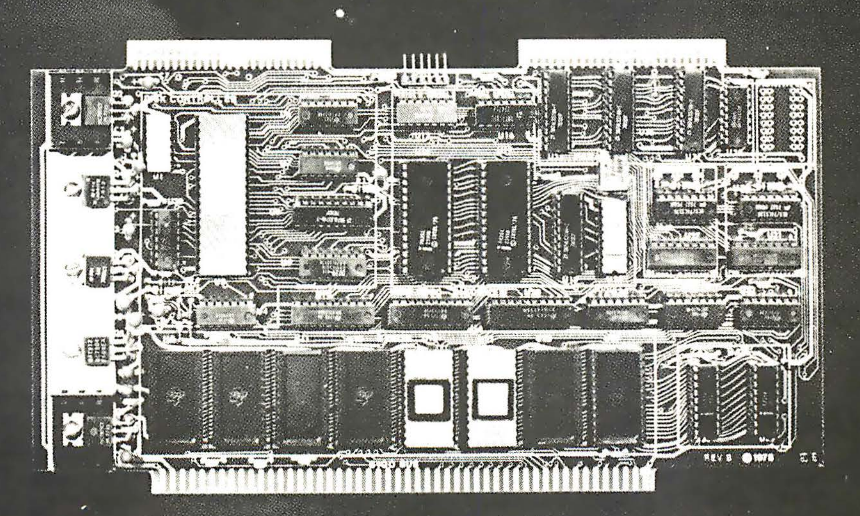
The system is remarkably compact, requiring only 1/2 to 1/3 the space taken by other 2-drive disk systems.

Less Hassle

The INFO 2000 Disk System eliminates the "I/O configuration blues" by incorporating all necessary interface ports. A CP/M Loader and all I/O drivers are contained in EPROM so there is no need for special software customization. Just plug the system into your S-100 microcomputer and begin immediate operation using the CP/M disk operating system. The INFO 2000 Disk System is supported by the most extensive library of software available, including 3 different BASICs, 2 ANSI FORTRAN IVs, several assemblers, text editors, debugging tools, utilities and numerous applications packages.

Less Errors

This disk system uses full size 8" diskettes and standard IBM 3740 recording format. So you're assured superior protection against errors, and full interchangeability with other CP/M-based systems.



It all adds up to more capability for your money.

The complete INFO 2000 Disk System comes completely assembled and tested. It includes dual diskette drives, the DISCOMEM Controller, power supply, cabinet, cables and the CP/M disk operating system––everything you need for immediate plug-in-and-go operation with your microcomputer. This means less time, hassle, hardware, space, errors and less money than for comparable equipment. Now, isn't that a lot less than you'd expected in a dual disk system?

Full price of S-100 Disk System is $2,600. Model without input/output facilities also available for $2,450. Delivery two weeks from receipt of order. INFO 2000 Disk Systems also available for Digital Group and Heath H8 microcomputers. Dealer inquiries welcomed.

*CP/M is a registered trademark of Digital Research.

INFO 2000
CORPORATION
20630 South Leapwood Avenue
Carson, California 90746
(213) 532-1702

Circle 178 on inquiry card.

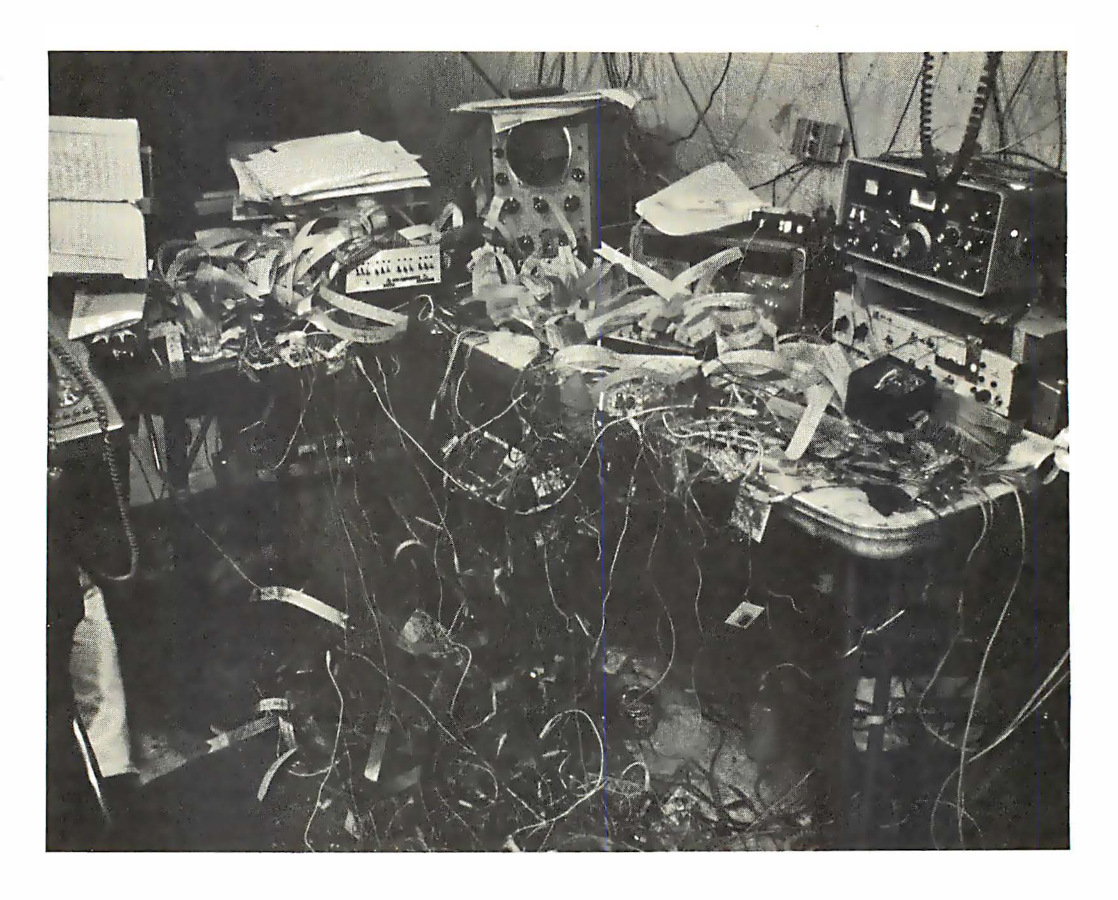


Photo 4: Roger Amidon's 4 bit processor, built in 1972 and fondly referred to as the "Spider." It was built with TTL logic and used to control an amateur radio (RTTY). The Spider was featured on the cover of April 1977 BYTE.

chip. Intel succeeded in doing this. Unfortunately, the device proved to be too slow for Datapoint's use. Intel decided, therefore, in 1971, to market the device for $200 and call it the 8008. It marked the first generation of "true" microprocessor integrated circuits.

The 8008 used an 8 bit data word with a more powerful instruction set than the 4004, but it still had many of the disadvantages of the 4004. It required considerable support logic. The 8008 however was a more general purpose device. For example, it contained a set of logical operations that the 4004 did not have. Its instruction set was similar to a minicomputer's, and it could directly address 16 K bytes of programmable memory. It even had interrupt capability.

At the same time, Intel introduced the 1101, a 256 by 1 bit programmable memory (which enabled the experimenter to build a 1 K by 8 bit memory with only 32 integrated circuits!), and the 1702 256 by 8 bit EROM. With the 8008, 1101 and 1702 integrated circuits, general purpose computers could now be built.

In 1972 several other manufacturers recognized this emerging market. Most notable was National Semiconductor who introduced the IMP-16, a chip set which may have been a little ahead of its time. It was a bit slice system of variable word length and user definable instruction set. It later developed into the third generation Pace microprocessor.

In late 1973, Intel introduced the 8080 processor, and, soon after, Motorola introduced the 6800. The 8080 has become the de facto industry standard, used in more applications than any other processor. The 8080 is basically an enhancement of the 8008. It came in a 40 pin dual in line package and could directly address 64 K bytes of programmable memory and read only memory. It had a true bidirectional data bus and an expanded instruction set. However, it still required an external clock and multiple power supplies. The 6800 on the other hand required only one TTL compatible power supply, had simpler control circuitry, and an instruction set more compatible with larger computers.

1975 and 1976 saw the introduction of enhanced third generation microprocessors. The Zilog Z-80, an enhanced 8080, featured a larger instruction set, more registers, on chip clock, and more. The 6502, from MOS Technology, was an enhancement of the 6800. The Texas Instruments TMS9900 and TMS9980 became the first widely available single chip 16 bit microprocessors.

1977 marked the introduction of the fourth generation of microprocessors. In fact, these devices now could be called

microcomputers in a single integrated circuit. These new devices include the complete microprocessor, read only memory, programmable memory, and IO circuitry on one chip. A minimum of support logic is required.

The future promises an increase in word size, functions, speed and memory capacity. (It looks like the single chip processor that runs BASIC may soon be a reality.) The next ten years in microprocessors and personal computing should be even more amazing than the past decade.■

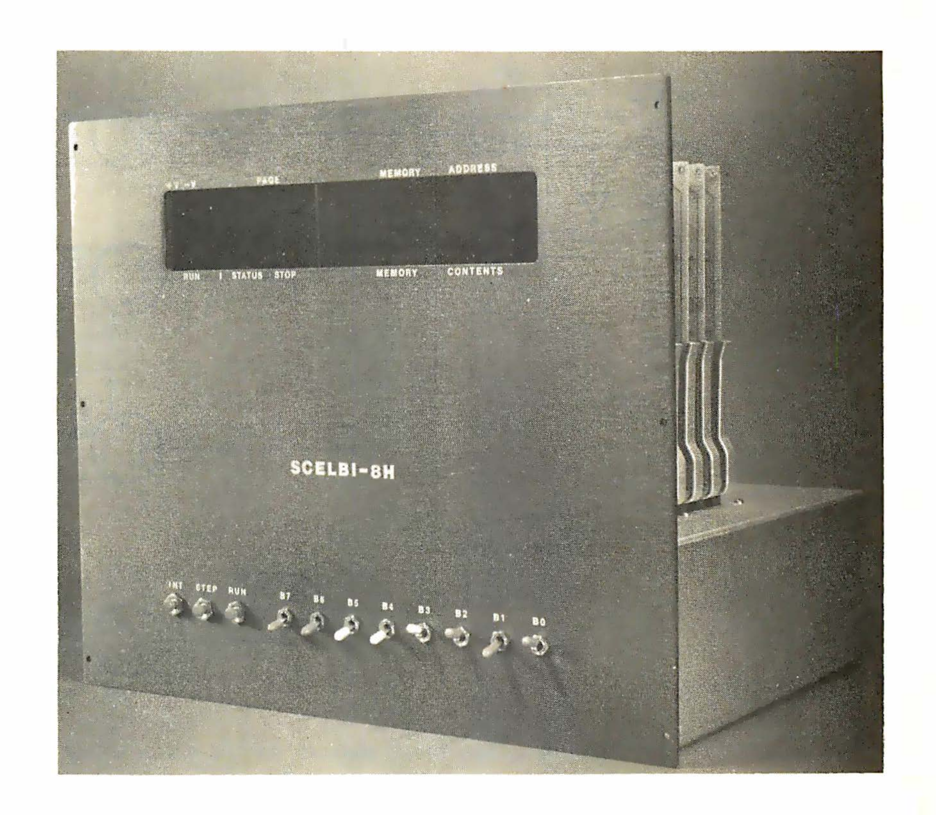


Photo 5: The Scelbi-8H processor. This was the first kit to utilize a microprocessor. It employed an Intel 8008 processor and was introduced in late 1973; design work began on the unit in August 1972. The prototype featured an oscilloscope display and audio tape unit. Scelbi has since discontinued their hardware line to concentrate on software and applications publications. The last Scelbi-8H was sold in December 1974.

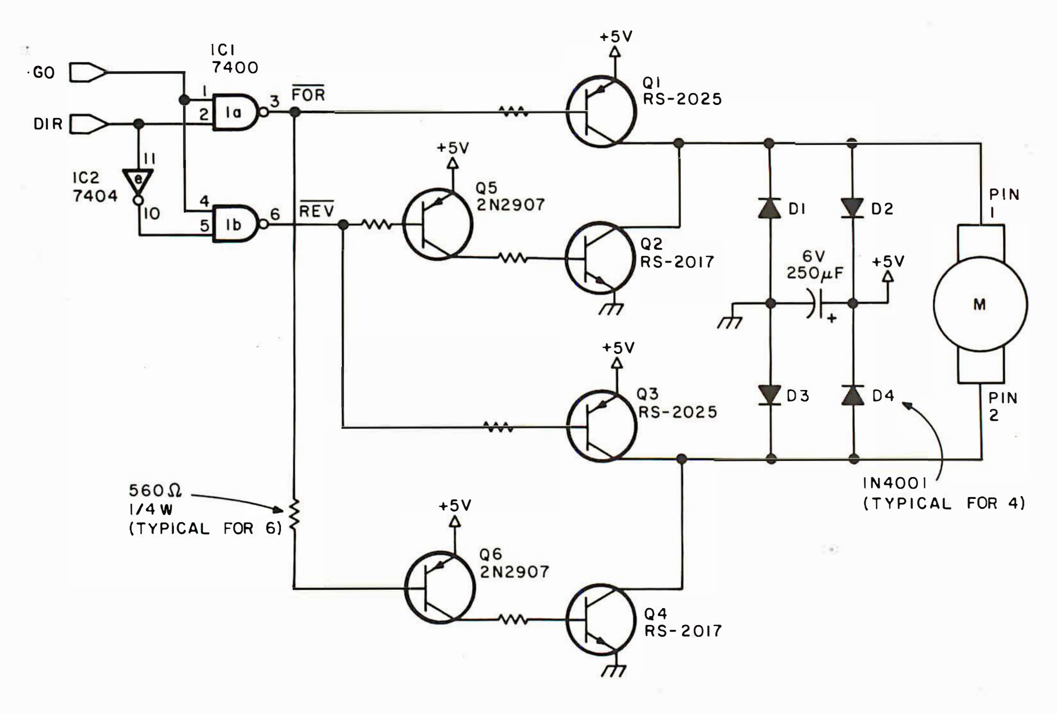


Figure 1: Schematic diagram for the motor driver. The 7400, IC1, has +5 V connected to pin 14 and pin 7 is connected to ground.

Controlling DC Motors

Robert L Walton
5616 Houston Rd
Eaton Rapids MI 48827

About the Author:

Robert Walton is a process computer engineer employed by Consumers Power Company. He has designed and homebrewed an 8008 based system with 9 K of memory, Kansas City audio tape interface, ASCII keyboard, 128 by 128 dot graphic video interface, and a front panel which allows examination and modification of contents in memory during program execution. More recently he has been experimenting with a KIM-1.

This article will explain one inexpensive way to control the position of a small 1.5 V to 3 V hobby DC motor to within a quarter turn out of a total range of 16,384 turns. Various types of mechanical apparatus may be attached to this shaft for accurate positioning. The feedback portion of this circuit may be used alone for position sensing of shafts which reverse direction during operation. Modifications to obtain resolution better than a quarter turn and to drive higher powered DC motors will be discussed.

The impetus for developing this circuit came while estimating the cost and complexity of implementing the circuit shown by Leon Sweer, Thomas Dwyer and Margot Critchfield in the article "Controlling Small DC Motors with Analog Signals" (August 1977 BYTE, page 18). My lack of a digital to analog converter, the apparently high power dissipation in the power op amp, and the mechanical complexity of the feedback potentiometer gear reduction were all negative factors. An "all digital" scheme was devised to overcome these problems.

The motor driver circuit is shown in figure 1. The circuit is simplified considerably by the presence of only three modes of operation: full forward, full reverse, and completely stopped. All transistors are in cutoff or saturation at all times. The signals labeled $\overline{FOR}$ and $\overline{REV}$ are at a high level, +5 V, while the motor is stopped. When $\overline{FOR}$ is brought low, Q1, Q4, and Q6 become saturated, or "turned on." This effectively connects motor pin 1 to +5 V and motor pin 2 to ground. When $\overline{REV}$ is brought low, Q2, Q3, and Q5 conduct, connecting motor pin 1 to ground and motor pin 2 to +5 V.

Note that $\overline{FOR}$ and $\overline{REV}$ must never be grounded simultaneously; if this situation occurs, heavy current will flow through Q1, Q2, Q3, and Q4, potentially damaging the devices. To eliminate the possibility of this happening due to a programming bug while the motor drive is connected to a computer, the $\overline{FOR}$ and $\overline{REV}$ signals have been modified to GO and DIR signals by the gate logic of IC1. The motor will be stopped as long as the GO signal is low. It will run forward

when GO and DIR are high, and reverse when GO is high and DIR is low. The DIR signal may be reversed with GO remaining high without damage. This reversal may occur as often as desired, even many times per second, without electronic damage. Diodes D1, D2, D3 and D4 are used to suppress switching transients from the motor.

Higher powered motors or higher voltage motors may be accommodated by using 7426 open collector gates in place of the 7400 gates or by using additional transistor driver stages, as appropriate.

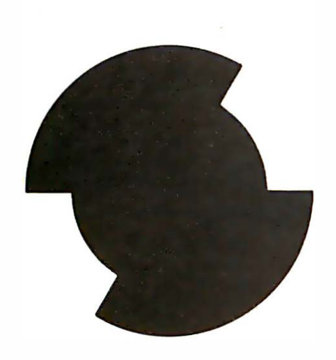


Figure 2: Opaque disk to be attached to motor shaft. Two gaps are cut so the disk will be rotationally balanced.

Position Feedback

Determining how many times a shaft has turned in one direction is simple. Attach an opaque disk with periodic gaps in it to the shaft as shown in figure 2. Shine a beam of light on one side of the disk and place a phototransistor on the other side. Apply the output of the phototransistor to a Schmitt trigger and count the high to low transitions. Note that it is not possible to determine the direction the shaft is rotating by observing the electrical signals generated.

By adding another phototransistor, it is possible to determine the direction the shaft is turning. The two phototransistors, identified as A and B, must be arranged as shown in figure 3. The direction of rotation can be determined by observing which phototransistor is the first one on when the gap is encountered as shown in figure 4. The direction can also be determined by observing which phototransistor is the last one off. It is really necessary to use both of these transitions in order to avoid miscounting when the oscillating situation explained in the caption of figure 5 is encountered.

The circuit to detect and register the shaft turns is shown in figure 6. This circuit functions by propagation delay. Signals A and B are high when their respective phototransistors are on. Signals AD and BD are signals A and B, respectively, delayed by passing through four inverters. Similar terminology applies to $\overline{A+B}$ and $(\overline{A+B})D$. These signals are then "anded" and "ored" together to make up and down counting signals for the four cascaded counters.

The four counters provide 16 bits of position information, or one part in 65,536. In the unlikely event that additional precision is required, more counters may be added. Note that the circuit generates four counts per revolution. If more counts per revolution are required, additional narrower gaps may be cut in the opaque disk and the phototransistors may be placed closer together.

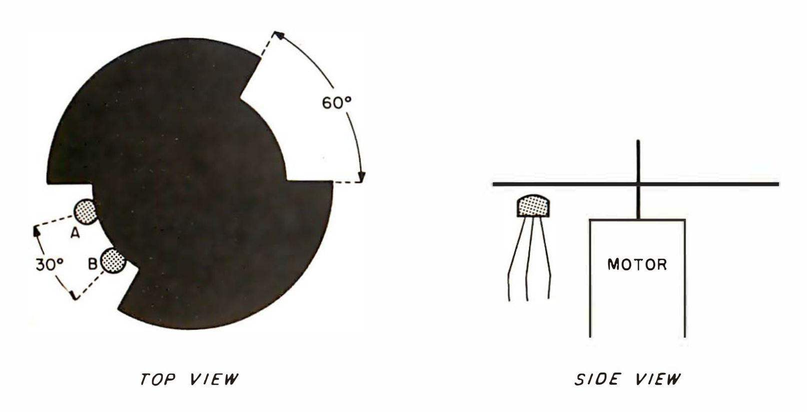


Figure 3: Placement of phototransistors A and B. The phototransistors should be within an eighth of an inch of the disk. The disk should be opaque and painted flat black. The 60° gap size and 30° placement of the phototransistors will provide a steady count once every 90° of rotation.

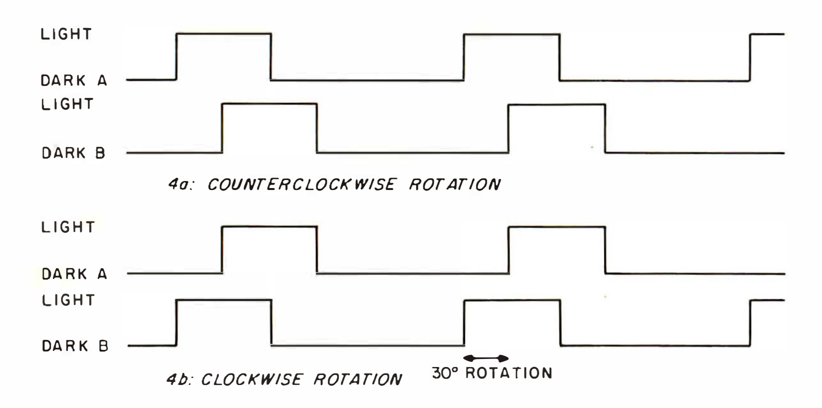


Figure 4: Phototransistor timing diagram. Note that the counter must count up when a dark to light transition occurs on A and B is dark, or when a light to dark transition occurs on B and A is dark. The counter must count down when a dark to light transition occurs on B and A is dark or when a light to dark transition occurs on A and B is dark. This assumes that a counterclockwise rotation causes an increase in count.

Construction

The opaque disk may be made from a sandwich of two index cards and aluminum foil glued together. The disk may then be drilled to fit the motor shaft and fastened with a drop of epoxy. If the motor shaft is mounted vertically with the disk up, the phototransistor may be mounted beneath the disk. An incandescent desk lamp may be used to illuminate the disk. The phototransistors may have to be adjusted a little to get the unit functioning. Be sure the collector of each phototransistor reads over 4 V when dark and under 0.5 V when illuminated. Be sure this is true all the way around the disk. Note: you will not be able to see the up and down counter inputs or the outputs of the four "and" gates on any but the very fastest oscilloscopes.

To test the circuit, wire the GO motor input high and wire pin 7 of IC7 (figure 6)

EDP books you can't afford to be without

any one of these great professional books for only $1.89

values up to $35.00

MICROPROCESSOR APPLICATIONS MANUAL
by Motorola, Inc.
435/278 Pub. Pr., $28.50 Club Pr., $22.50

PROGRAMMING LANGUAGES
by A. B. Tucker, Jr.
654/158 Pub. Pr., $17.50 Club Pr., $13.50

ILLUSTRATING BASIC
(A Simple Programming Language)
by D. Alcock
771/928 Pub. Pr., $10.95 Club Pr., $8.95

AUTOMATIC DATA PROCESSING HANDBOOK
by The Diebold Group, Inc.
168/075 Pub. Pr., $33.50 Club Pr., $23.75

MICROPROCESSOR PROGRAMMING FOR COMPUTER HOBBYISTS
by N. Graham
783/56X Pub. Pr., $12.95 Club Pr., $10.95

THE COMPULATOR BOOK
Building Super Calculators & Minicomputer Hardware with Calculator Chips
by R. P. Haviland
783/578 Pub. Pr., $10.95 Club Pr.. $9.30

MICROCOMPUTERS/MICROPROCESSORS:
Hardware, Software and Applications
by J. L. Hilburn & P. N. Julich
771/499 Pub. Pr., $19.50 Club Pr., $15.60

INTERACTIVE COMPUTER GRAPHICS
by B.S. Walker, G. R. Grund & E. A. Drawneck
767/661 Pub. Pr., $14.50 Club Pr., $12.30

THE INFORMATION SYSTEMS HANDBOOK
by F. W. McFarlan & R. L. Nolan
769/29X Pub. Pr., $35.00 Club Pr., $25.50

MINICOMPUTERS: Structures and Programming
by T. G. Lewis & J. W. Doerr
773/009 Pub. Pr., $13.95 Club Pr., $10.95

GETTING INVOLVED WITH YOUR OWN COMPUTER
A Guide for Beginners
by L. Solomon & S. Veit
771/952 Pub. Pr., $9.95 Club Pr., $8.35

ALGORITHMS + DATA STRUCTURES = PROGRAMS
by N. Wirth
769/664 Pub. Pr., $19.00 Club Pr., $13.75

ADVANCED ANS COBOL WITH STRUCTURED PROGRAMMING
by G. D. Brown
772/118 Pub. Pr., $19.95 Club Pr., $15.95

APPLYING MICROPROCESSORS
New Hardware, Software & Applications
Edited by L. Altman & S. E. Scrupski
191/603 Pub. Pr., $19.50 Club Pr., $12.50

MICROPROGRAMMING PRIMER
by H. Katzan, Jr.
333/874 Pub. Pr., $17.95 Club Pr., $13.95

A DISCIPLINE OF PROGRAMMING
by E. W. Dijkstra
770/115 Pub. Pr., $18.95 Club Pr., $15.75

Introductory offer to new members of the
Computer Professionals' Book Club

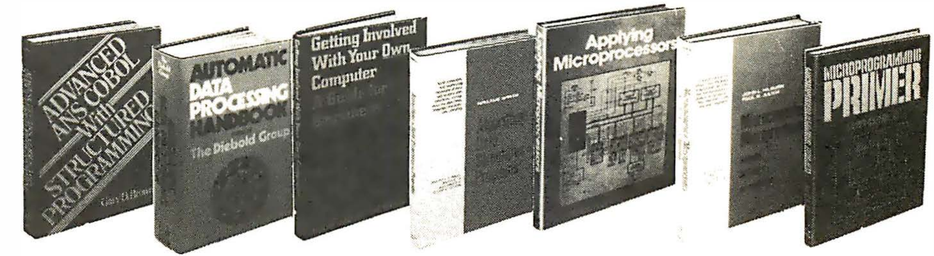
Special $1.89 bonus book comes to you with your first club selection

THIS new professional club is designed to meet your day-to-day on-the-job needs by providing practical books in your field on a regular basis at *below publisher prices.* If you're missing out on important technical literature—if today's high cost of reading curbs the growth of your library—here's the solution to your problem.

The Computer Professionals' Book Club was organized for you, to provide an economical reading program that cannot fail to be of value. Administered by the McGraw-Hill Book Company, all books are chosen by qualified editors and consultants. Their understanding of the standards and values of the literature in your field guarantees the appropriateness of the selections.

How the Club operates: Every month you receive free of charge *The Computer Professionals' Book Club Bulletin.* This announces and describes the Club's featured book of the month as well as alternate selections available at special members' prices. If you want to examine the Club's feature of the month, you do nothing. If you prefer one of the alternate selections—or if you want no book at all—you notify the club by returning the card enclosed with each *Bulletin.*

As a Club Member, you agree only to the purchase of four books (including your first selection) over a two-year period. Considering the many books published annually, there will surely be at least four you would want to own anyway. By joining the club, you save both money and the trouble of searching for the best books.



VALUES UP TO $35.00 WITH MAJOR DISCOUNTS ON ALL OTHER CLUB SELECTIONS. Your bonus books come with the first selection, and you may choose both of them from the books described in this special introductory offer.

EXTRA SAVINGS: Remit in full with your order, plus any local and state tax, and McGraw-Hill will pay all regular postage and handling charges.

NO RISK GUARANTEE:
If not completely satisfied return selections for full refund and membership cancellation.

MAIL THIS COUPON TODAY

COMPUTER PROFESSIONALS/Book Club P.O. Box 582 Princeton Road, Hightstown, New Jersey 08520

Please enroll me as a member and send me the two books indicated. I am to receive the bonus book at the introductory price of $1.89 plus my first selection, plus tax, postage, and handling. If not completely satisfied, I may return the books within 10 days and request that my membership be cancelled. If I keep the books, I agree to take a minimum of three additional books during the next two years at special Club prices (guaranteed 15% discount, often more). I will receive the Club Bulletin 13 times a year. If I want to examine the featured selection, I need take no action. It will be shipped automatically. If, however, I want an alternate selection—or no book at all—I simply notify the Club by returning the convenient card always enclosed. I will always have a minimum of 10 days in which to return the card and you will credit my account fully, including postage, if this is not the case. Membership in the club is continuous but cancellable by me at any time after the four-book purchase requirement has been filled. *This order subject to acceptance by McGraw-Hill. Orders from outside the continental U.S. must be prepaid. Company, business, or institutional tax exemption status is not appliable to purchases made through individual Club memberships. All prices subject to change without notice. Offer good for new members only. A shipping and handling charge is added to all shipments. Members are billed when books arrive.*

Write Code # of $1.89 bonus book selection here ______

Write code # of first selection here ______

NAME ______

ADDRESS ______

CITY ______

STATE ______ ZIP ______

P39299

Circle 219 on inquiry card.

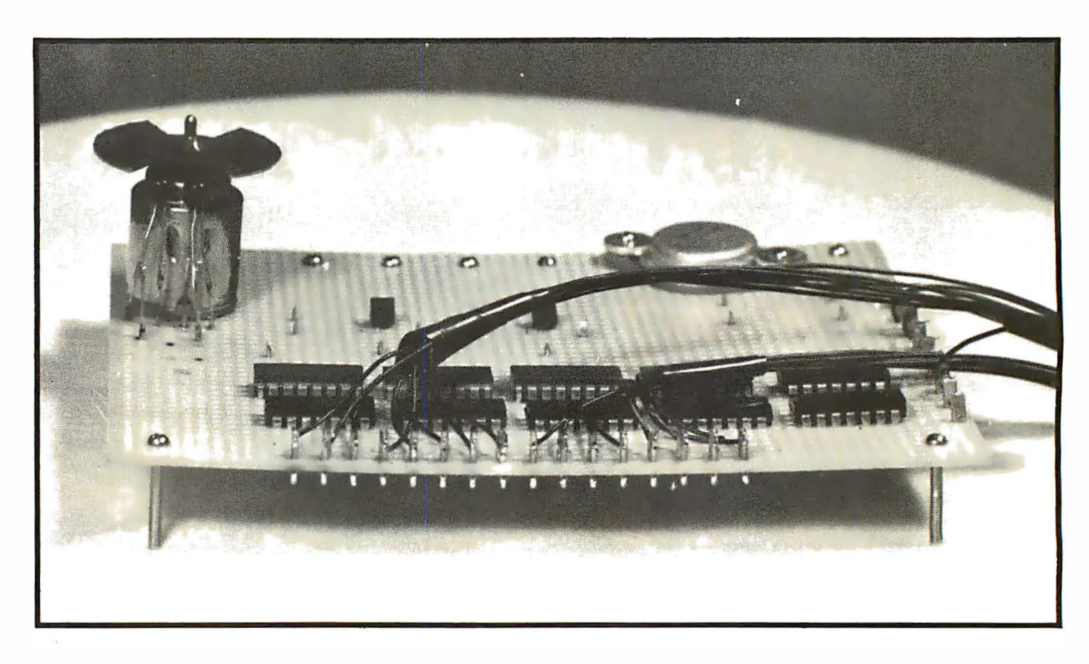


Photo 1: A breadboard of the motor controller. The photocells may be seen in front of the motor.

to the motor DIR input. Tie the LOAD input (figure 6) to +5 V. The motor should seek one end of one of the gaps and "chatter" there. The rate of chatter may be anywhere from five to 100 times per second. The angle the disk turns during this chatter should be only a few degrees. Experiment with the lighting to obtain the fastest chatter rate. Passing your hand in front of the lamp will cause the motor to run away. When your hand is removed, the shaft will again seek a position.

Use

It is wise to have a mechanical arrangement using a slipclutch or a similar device to prevent mechanical or electrical damage if the motor runs away. Such an accident could result from a program problem or a burnt out light source. Such an arrangement also provides the facility for automatically zeroing the position when power is first applied to the circuit. The motor is driven in one direction long enough to ensure that the slipclutch is slipping, and then the LOAD line is momentarily lowered to load the counters with the known position. The counters will then contain the correct absolute position until power is turned off or the slipclutch operates again.

To set the motor to a specific position, perform the program in listing 1 (flowchart

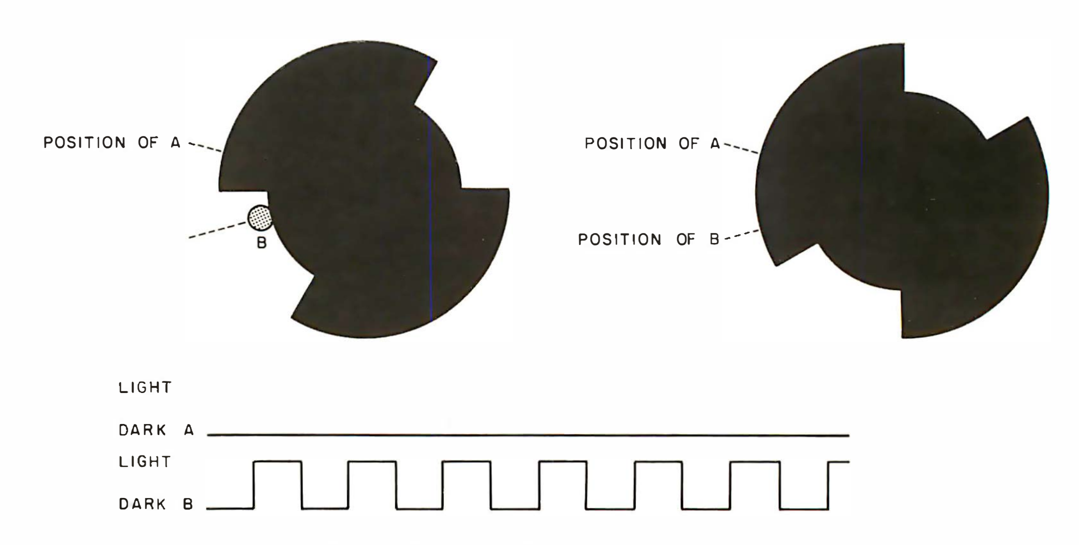


Figure 5: Reason for decoding trailing edge of signals. A 30° oscillation of the disk between the positions shown will create the above waveform. If the trailing edge was not decoded, the counter would be decremented once for each oscillation and lose track of the correct position.

in figure 7) at least twenty times per second. On an 8 bit machine, reading a 16 bit real time quantity poses a problem. If one byte is read and then the other, there is a real possibility that the 16 bit input may have changed between the two operations. Therefore the position is read twice and checked for agreement before proceeding. With a 16 bit machine, only a single input operation need be performed.

The motor will race at top speed toward the desired setting. When it goes past the setting, it will turn around and race back, again overshooting. After a couple of quick oscillations, the desired position will have been reached and the motor will shut off. A better algorithm could be devised by estimating the speed of the motor and anticipating the overshoot, causing the motor to approach zero speed very close to

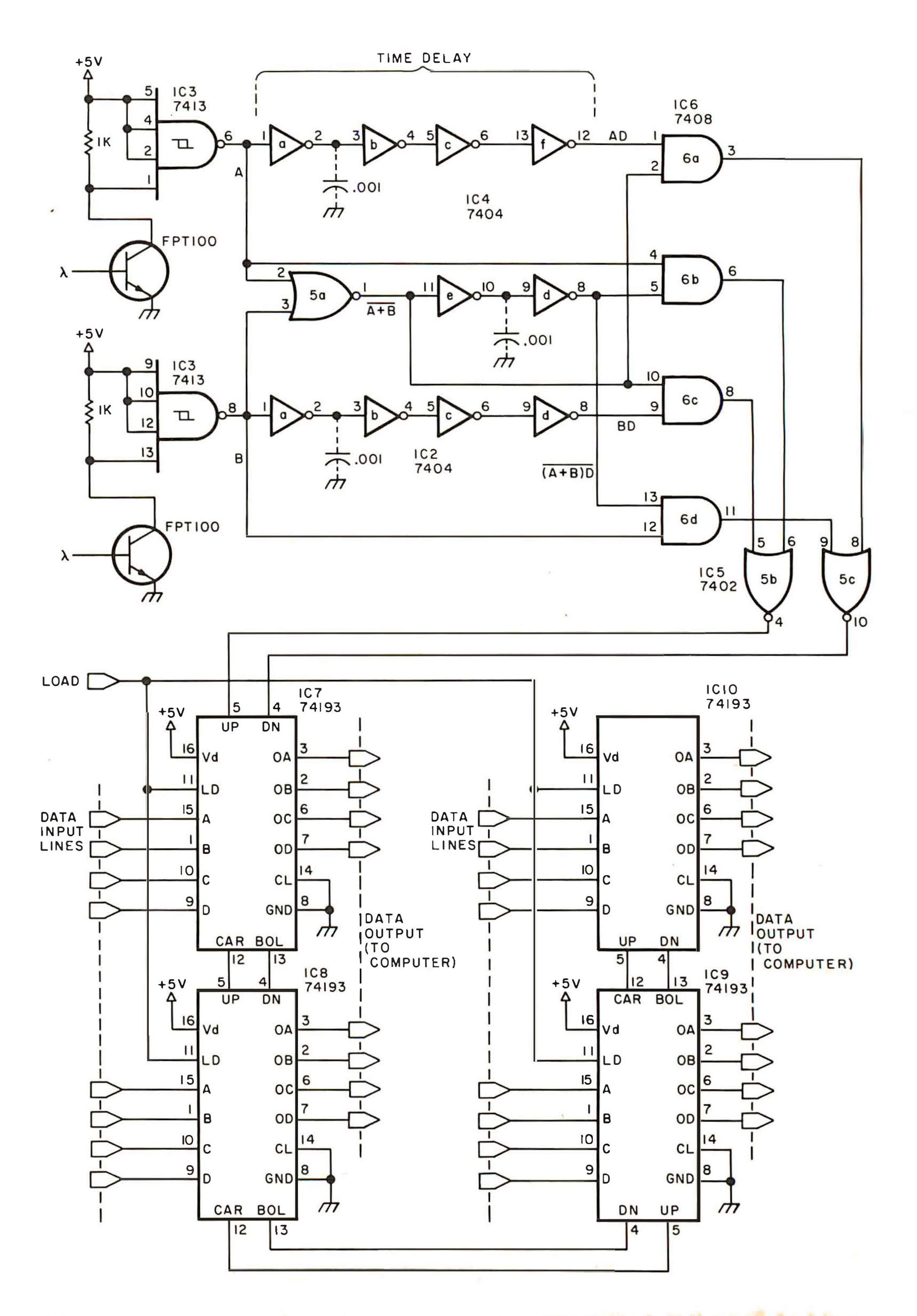
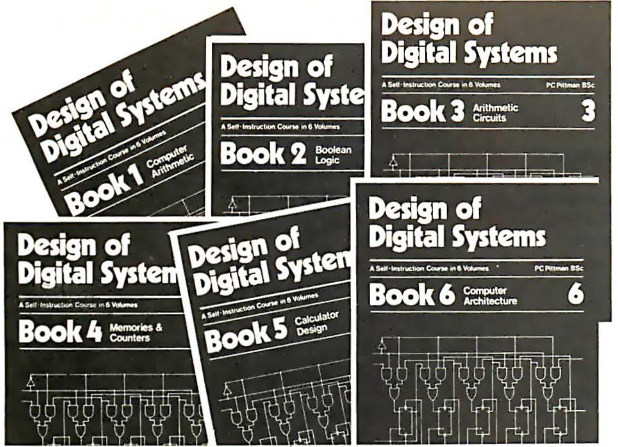


Figure 6: Schematic diagram for the encoder circuit. The data input lines should be wired to the state corresponding to the desired initial position of the motor. The dotted in capacitors may be required to obtain sufficiently wide clock pulses for the up and down counters.

Personal Computers & Microprocessing

Here are two inexpensive programmed learning courses designed to keep you up-to-date in digital electronics.



Design of Digital Systems - six volumes

The products of digital electronics technology will play an important role in your future. Calculators, digital watches and TV games are already commonplace. Now, microprocessors are generating a whole new range of products. Personal computers will be in widespread use very soon. Your TV, telephone and computer will combine to change your children's education, your job—your entire way of life.

WRITTEN BY EXPERTS

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and respond by answering questions on each new piece of information before proceeding.

After completing these courses you will have broadened your career prospects as well as your understanding of the rapidly changing technological world around you.

The courses are designed as much for the professional engineer as for the amateur enthusiast. You'll learn about microprocessing as well as personal computing — not to mention all the other aspects of digital electronics design.

ADVANCED COURSE
DESIGN OF DIGITAL SYSTEMS

Design of Digital Systems is written for the engineer and serious hobbyist who wants to learn more about digital electronics. Its six large-format volumes—each 11¼" x 8¼" are packed with information, diagrams and questions designed to lead you step by step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of microprocessors and computers.

CONTENTS

The contents of Design of Digital Systems include:

Book 1: Octal, hexadecimal and binary number systems; representation of negative numbers; complementary systems; binary mulitplication and division.

Book 2: OR and AND functions; logic gates; NOT, exclusive-OR, NAND,NOR and exclusive - NOR functions; multiple input gates; truth tables; DeMorgan's Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.

Book 3: Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.

Book 4: Flip-flops; shift registers; asynchronous counters; ring, Johnson and exclusive -OR feedback counter; random access memories (RAMs); read-only memories (ROMs).

Book 5: Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.

Book 6: Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; executive programs, operating systems, and time-sharing.

Also available at leading computer stores:
Computer Mart of New York, 118 Madison Ave., New York, NY.
Erie Computer Co., 1253 West 8th St., Erie, PA.
Interactive Computers, 7646½ Dashwood, Houston, TX.
Interactive Computers, 16440 El Camino Real, Houston, TX.
Interactive Computers, 217 W. San Francisco, Sante Fe, NM.
Readout Computer Stores, 6 Winspear Ave., Buffalo, NY.
Imperial Computer Systems, Inc., 2105 23rd Ave., Rockford, IL.
Horne Computer Center, 6101 Yonge St., Willowdale, Ontario, Canada
and many others. Ask your dealer.

BASIC COURSE



Digital Computer Logic & Electronics

CONTENTS

Digital Computer Logic and Electronics is designed for the beginner. No mathmetical knowledge other than simple arithmetic is assumed, though you should have an aptitude for logical thought. It consists of 4 volumes—each 11½" x 8¼"—and serves as an introduction to the subject of digital electronics.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; DeMorgan's Laws; design of logical circuits using NOR gates; R-S and J-K flip-flops; binary counters, shift registers and half-adders.

NO RISK GUARANTEE

There's absolutely no risk to you. If you're not completely satisfied with your courses, simply return them to GFN within 30 days. We'll send you a prompt, full refund, **Plus return postage.**

TAX DEDUCTIBLE

In most cases, the full cost of GFN's courses can be a tax deductible expense.

HOW TO ORDER

To order by credit card, call GFN's toll-free number — **(800)331-1000**; or send your check or money order (payable to GFN Industries, Inc.) to the address below.

Prices include overseas surface mail postage. **Air Mail:** additional costs (10 volumes); Caribbean $10; Europe $15; Africa, South America $20; Australia, Asia $25; or write for exact quote

Write for educational discounts, quantity discounts and dealer costs.

LOW PRICES – SAVE $5

We ship promptly from stock. There are **no extras**—we pay all shipping costs; we even pay your sales tax where required. And if you order both courses, you save $5. Order at no obilgation today.

Design of Digital Systems - 6 volumes *$19.95*

Digital Computer Logic & Electronics - 4 volumes *$14.95*

Both courses - 10 volumes *$29.90*



GFN Industries, Inc.
Suite 400-B
888 Seventh Ave.
New York
N.Y. 10019

Call TOLL-FREE (800) 331-1000
(orders only)

Octal Address	Operation Codes		Mnemonic	Commentary
001 000	066 aaa		LLI aaa	set memory address
001 002	056 bbb		LHI bbb	registers to location of high byte of desired position
001 004	101	READ	INP 0	get low byte of current position
001 005	310		LBA	save in B register
001 006	107		INP 3	get high byte of current position
001 007	320		LCA	save in C register
001 010	101		INP 0	read low byte again
001 011	271		CPB	compare to previous read
001 012	110 004 001		JFZ READ	re-read if not same
001 015	107		INP 3	read high byte again
001 016	272		CPC	compare to previous read
001 017	110 004 001		JFZ READ	re-read if not same
001 022	277		CPM	compare high byte with desired high byte
001 023	140 047 001		JTC LOW	jump if less
001 026	110 054 001		JFZ HIGH	jump if greater
001 031	301		LAB	high byte equal-recall low byte to A
001 032	061		DCL	decrement address registers to point to low byte of desired position
001 033	277		CPM	compare low byte to desired low byte
001 034	140 047 001		JTC LOW	jump if less
001 037	110 054 001		JFZ HIGH	jump if greater
001 042	006 000		LAI 0	equal, set A for DIR and GO = 0
001 044	104 056 001		JMP OUT	go output DIR & GO
001 047	006 002	LOW	LAI 2	position low — set GO = 1, DIR = 0
001 051	104 056 001		JMP OUT	go output GO & DIR
001 054	006 003	HIGH	LAI 3	position high — set GO = 1, DIR = 1
001 056	127	OUT	OUT3	output GO and DIR

Listing 1: Intel 8008 program for motor control. This segment of code should be executed at least 20 times per second. The desired position is in location bbb-aaa (high byte) and the next previous location (low byte). The two locations must be on the same page. Input port 0 is the low byte of the counter and port 3 is the high byte. Output port 0 has DIR in its least significant bit and GO in the next bit.

the desired position. Such a scheme would reduce the settling time of the system to a minimum.

Modifications

For those purists who insist on doing everything in software, the Schmitt trigger outputs may be tied directly to two computer input lines, or even interrupt lines, and the decoding and counting may be done in the computer. For those other purists who prefer not to tie their machine up with repetitive loops such as the one in figure 7, this positioning scheme may be implemented in hardware by installing four 4 bit comparators on the counter outputs. Cascade the comparators together and connect two output ports from a computer to the other comparator inputs. Invert the "equal" comparator output and connect it to GO. Connect the "greater than" comparator output to DIR. If the motor runs away connect the "less than" comparator output to DIR. Now the computer outputs 16 bit position values and the circuit positions the motor to follow the computer output.■

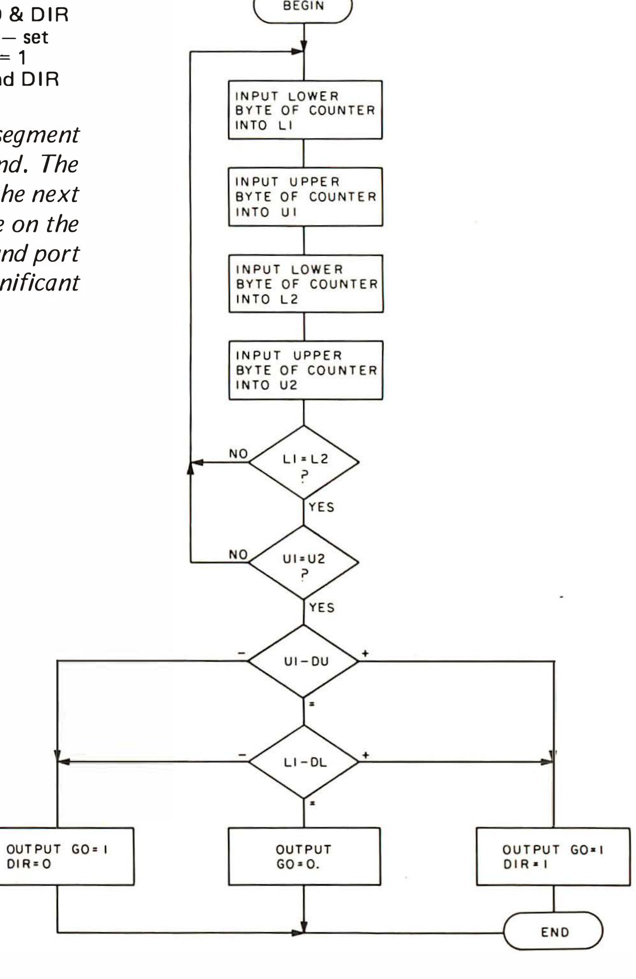


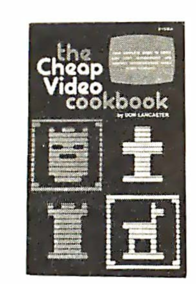
Figure 7: Program flowchart. Variables DU and DL hold the upper and lower bytes of the desired position. This program must be executed at least 20 times per second. If the motor runs away, complement the DIR bit outputs. Do not attempt to reach positions closer than 50 turns to 0 or 65535 with this algorithm because of the counter overflow which occurs.

See our ad on page 151.

Books to Make the Summer

Just Arrived!



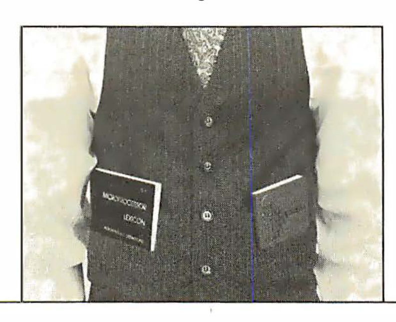


____**The Cheap Video Cookbook,** the latest in Don Lancaster's series of hardware books, continues where the **TV Typewriter Cookbook** leaves off. New, inexpensive video display circuits (and the software to drive them) are described. The designs allow a variety of alphanumeric and graphics formats to be implemented, including high resolution graphics. The circuits are designed for use on 6500 or 6800 systems, but can be adapted to other processors. Chapters also cover methods for displaying memory contents and a description of transparency techniques. 256 pp. $5.95.

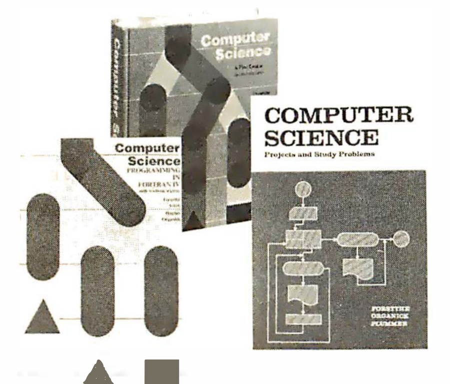
____**BASIC: A Hands-on Method** by Herbert D Peckham is a light-hearted but thorough self-study course in BASIC, designed for people new to the subject. The introduction defines what BASIC is, gives some background on its origins, and tells you how to get started. Chapters cover: computer arithmetic and program management; input, output and simple applications; decisions and branching; looping; working with collections of numbers; subroutines; and more. Although the book is oriented towards the implementation of BASIC on time sharing terminals, the ideas and techniques are applicable to the personal computer. 244 pp. $7.95.

Not Just a Good Buy But An Investment

____**Microprocessor Lexicon, Acronyms and Definitions** by SYBEX. 110 pp. This little book is a necessity to anyone who wants an explanation of those hard-to-fathom acronyms and other micro terms. Included are sections on signals in the main standards, functions of essential chips, and more. At 4½" x 5½" it can be pocketed easily. For only $2.95 every microcomputerphile should have a copy.



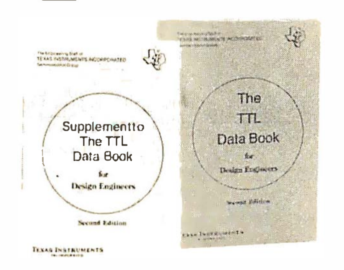
____**The 8080 Programmer's Pocket Guide** written by Scelbi Computer Consulting Inc is a handy 3" x 4" compendium of 8080 facts. Included are detailed descriptions of the 8080 instruction set, information about an 8080 paper tape loader program, and an instruction set summary and index. 8080 programmers will want a copy of this useful book. 130 pp. Only $2.95.



____**Computer Science: A First Course, Second Edition,** by Forsythe, Keenan, Organick, and Stenberg. Over 760 pp. $18.25 hardcover.

____**Computer Science: Projects and Study Problems** by A I Forsythe, E I Organick, and R C Plummer. This companion text to **Computer Science: A First Course** is a series of work problems designed to intrigue the reader. Problems include plotting graphs, simultaneous equations, the eight queens problem, designing a perceptron (a machine that learns), as well as a series of problems specifically designed to complement the chapters of **Computer Science: A First Course.** 292 pp. $9.75.

____**Computer Science: Programming in FORTRAN IV** by A I Forsythe, R M Aiken, C E Hughes, and E I Organick. This supplement to **Computer Science: A First Course, Second Edition,** shows how to turn flowcharts into equivalent FORTRAN programs. Features include chapters on FORTRAN IO statements, assignment statements, rounding, formatting, subroutines, practical applications, etc. The advent of FORTRAN software packages for small systems makes this a timely addition to the literature. 210 pp. $5.25.



____**The TTL Data Book for Design Engineers, Second Edition,** by Texas Instruments is a current source of information on the design specifications and characteristics of the Texas Instruments 7400 series of devices. In it you'll find a complete section of 7400 series pinout diagrams at the front, plus the usual detailed descriptive information on the more complicated circuits. How do you find out what a 74412 does? Turn to its pinout diagram on page 5-74, then vector to the detail information on page 7-502 where you discover that it's Texas Instruments' version of the Intel 8212 part. 828 pp. Only $4.95 hardcover.

____**Supplement to the TTL Data Book for Design Engineers, Second Edition,** by Texas Instruments. As the name implies, this supplement brings your Texas Instruments **TTL** Data **Book** up to date with the latest information about new TTL devices. The 56-page book includes information about synchronous counters, function generators, and many other devices. $1.25.

BITS T.M. The Microcomputer Bookstore

Last All Year Long

Business

____**BASIC with Business Applications** by Richard W Lott focuses on the BASIC language and its application to specific business problems. The book is divided into two sections. Part one introduces the BASIC language and the concept of logical flowcharting. Part two presents problems and possible solutions. Topics include: interest rate calculation, break-even analysis, loan rates, and depreciation. Exercises at the end of each chapter give a greater understanding of BASIC by actual programming. This book is a great aid to the beginner wanting to learn BASIC without having a technical or scientific background. 284 pp. $10.50.

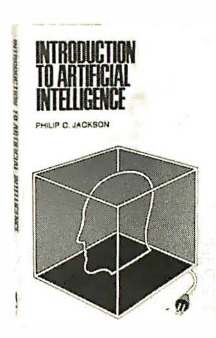
____**Financial Analysis and Business Decisions on the Pocket Calculator** by Jon M Smith is designed to aid the experimenter in performing applied analysis. It gives a variety of numerical techniques, approximations, tables, graphs, and flowcharts for calculations. All methods have been optimized for the pocket calculator, and the book stresses the use of the business-type calculator having the usual complement of business functions. Topics include: calculating present and future values, consumer finances, real estate calculations, business statistics, and systems analysis. 317 pp. An invaluable source tool at $14.95 hardcover.

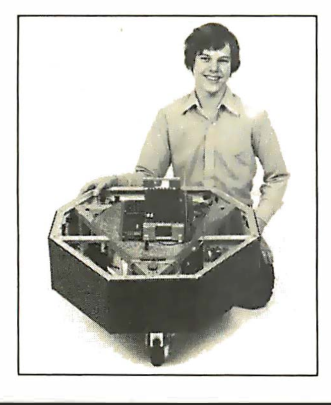
____**Charging for Computer Services** by D Bernard, J C Emery, R L Nolan, and R H Scott is written for managers who must deal with service charges. This book provides the manager with principles and guidelines for a better understanding of the charge problem. The book provides general design principles along with specific suggestions to deal with specific problem areas. **Charging for Computer Services** is a necessary book for the manager who must make decisions in this vital area. 120 pp. $10.00 hardcover.



A.I.

____**Introduction to Artificial Intelligence** by Philip C Jackson Jr surveys the field beginning with Turing's test, the mathematical description of phenomena, finite state machines and limits to computational ability, followed by chapters on problem solving, game playing, pattern perception, theorem proving, semantic information processing, parallel processing, evolutionary systems, robots, and a look at the future of the field. This thoughtful and unusual book will make a useful addition to your library. A 50-page bibliography is included. 453 pp. $18.50 hardcover.





Just Out!

____**How to Build a Computer-controlled Robot** by Tod Loofbourrow. This book combines the dream of robotics—to create an intelligence other than human—with the reality, by providing both hands-on experience with robotics and an application of a microprocessor. You can learn the fundamentals while utilizing the ultimate in current hobby computer technology. This book details the step-by-step directions for building a robot, named "Mike," controlled by a KIM-1 microprocessor, with the complete control programs clearly written out. Photographs, diagrams, and tables help to direct you in the construction. $7.95.

BITS T.M.

The Microcomputer Bookstore
25 Route 101 West
Peterborough, NH 03458

DIAL YOUR BANK CARD ORDERS ON OUR **TOLL-FREE HOT LINE: 1-800-258-5477.**

Name ____________

Address ____________

City ________ State ________ Zip ________

Signature ____________

☐ My check enclosed:

Check #: ____________

Amount: ____________

☐ My card #: ____________

Expires: ____________

	Total
Number of books ______	______
Postage $.75/book or $1.00 outside U.S.	______
Grand Total	______

Prices subject to change without notice. *Dealer Inquiries Invited.* *You may photocopy this page.*

Circle 35 on inquiry card.

A Short History of Computing

Keith S Reid-Green
Director, Software Systems Development
Educational Testing Service
Princeton NJ 08540

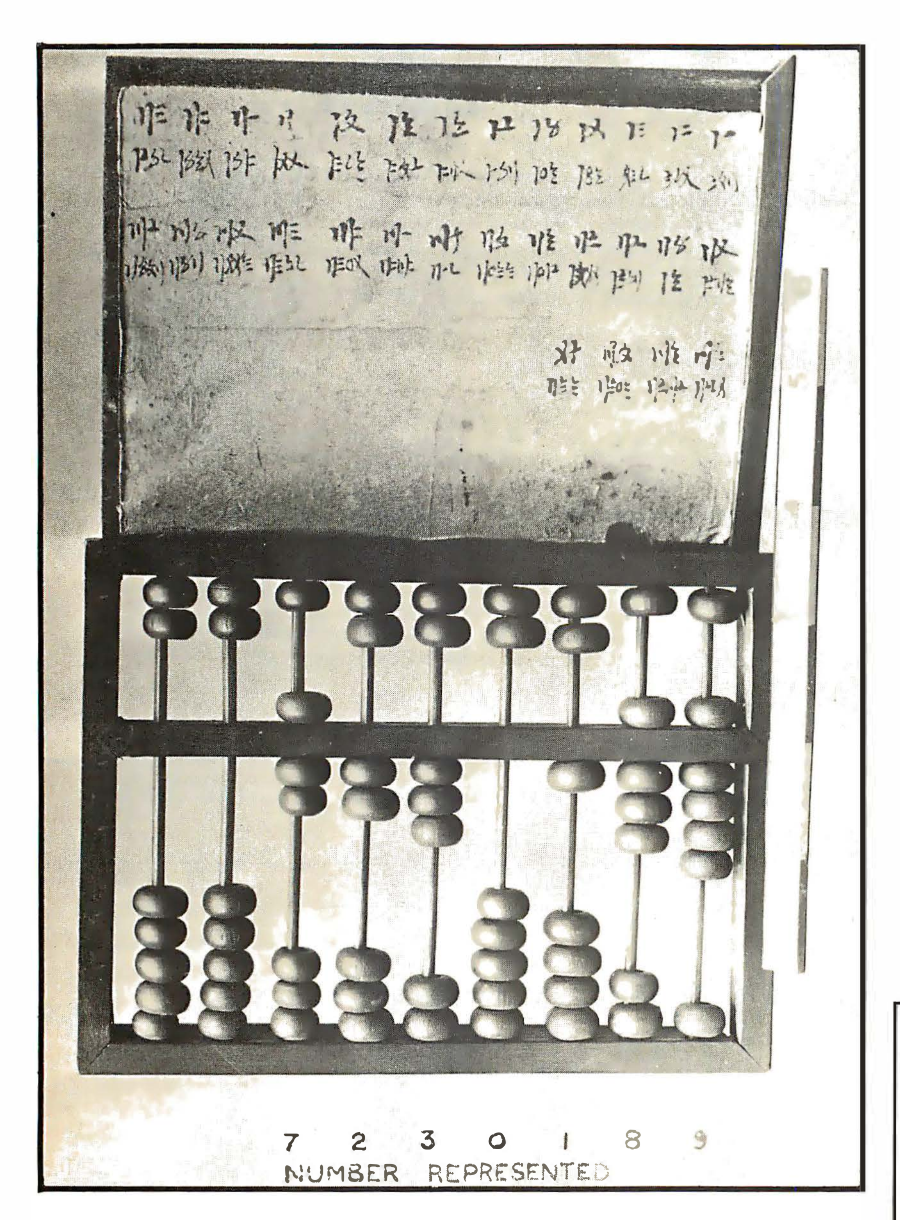


Photo 1: A Chinese abacus.

A few weeks ago a master's degree candidate in computer science confided, with an embarrassed laugh, that he had never seen a computer. His experience with the machines of his chosen vocation had consisted entirely of submitting punched cards through a hole in a wall and later getting printed results the same way. While his opportunities to see equipment are restricted due to his student status, there are also thousands of working programmers and analysts using large scale equipment who have no contact with existing hardware and will never have a chance to see any first or second generation computers in operation.

This is in sharp contrast with the way programmers worked in the late 1950s and early 1960s. Before 1964, when multiprogramming computers were introduced, the typical programmer had opportunities to come in contact with the computer if he or she wanted to do so. Prior to 1960, in fact, most programmers actually operated the machine when debugging their programs. These people learned of the computer as a physical device; the current programmer is more likely to think of it as a vague logical entity at the other end of a terminal. Thus, many large system programmers have the rare distinction of using a tool without knowing how it works or what it looks like. This is in spite of the fact that many important computer developments have

Photo Acknowledgements

Photos 1 and 3 courtesy of Bettmann Archive, New York.
Photos 2, 4, 5, 6, 7, and 8 courtesy of the IBM Corporation.
Photo 9 courtesy of Cray Research Inc.
Photo 10 courtesy of the Sperry Rand Corporation.

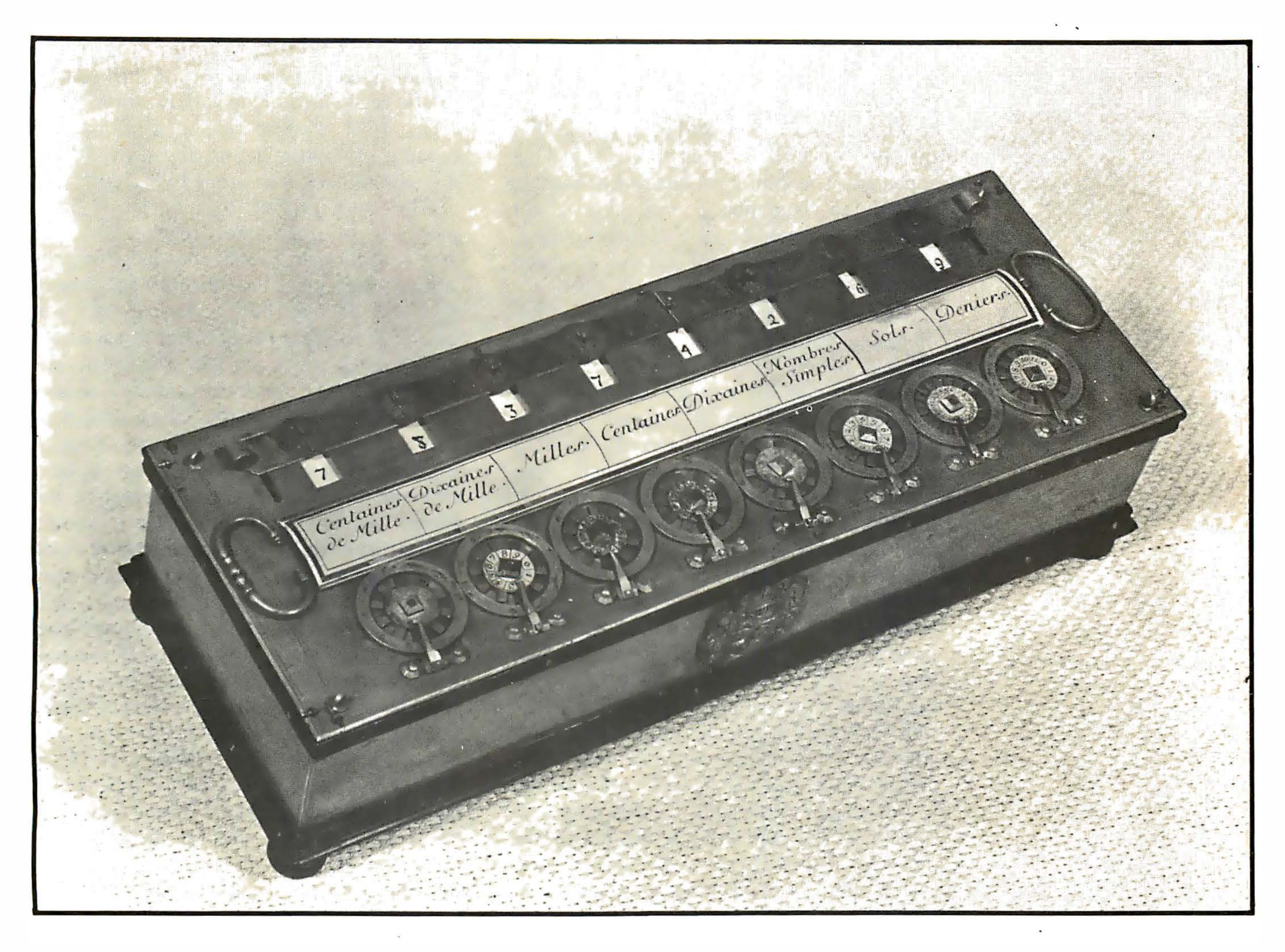


Photo 2: Pascal's adding machine. Note that the rightmost dial has 12 positions and its neighbor has 20. The machine was intended for calculations involving the French currency of the period.

occurred within the average programmer's lifetime.

However, in the past year or two, dramatic reductions in the cost of minicomputer components and the advent of the microcomputer have returned the hands-on computer to respectability in two ways. First, it is now possible to justify hands-on debugging on a small computer, since the hourly rate of the programmer is higher than that of the machine. Second, the decreasing cost of home computing has fostered the birth of a new class of "renaissance programmers": people who combine programming expertise with hardware knowledge and aren't afraid to admit it. Renaissance programmers can learn much from the lessons of computer history; simple and inelegant hardware isn't necessarily best, but it's frequently cheapest.

In short, the stored program computer became a necessary tool only recently, even though various mechanical aids to computation have been in existence for centuries. One of the first such aids was the abacus, the invention of which is claimed by the Chinese. It was known in Egypt as early as 460 BC. The Chinese version of the abacus (as shown in photo 1) consists of a frame strung with wires containing seven beads each. Part of the frame separates the topmost two beads from the lower five. The right-hand wire represents units, the next tens, the next hundreds, and so on. The operator slides the beads to perform addition and subtraction and reads the resulting sum from the final position of the beads. The principle of the abacus became known to Roman and early European traders, who adopted it in a form in which stones (called by the Latin *calculi*, hence the word "calculate") are moved around in grooves on a flat board.

The use of precision instruments dates back to the Alexandrian astronomers. Like the mathematics of the period, however, the development of scientific instruments died away with the demise of the Alexandrian

school. The Arabs renewed interest in astronomy in the period between 800 and 1500 AD, and it was during this time that the first specialists in instrument making appeared. The center of instrument making shifted to Nuremberg, beginning about 1400. By the middle of the 16th Century, precise engraving on brass was well advanced due in part to the interest in book printing.

Calendrical calculators used for determining the moon's phases and the positions of the planets crop up in all the major periods of scientific thought in the past two thousand years. Parts of a Greek machine about 1800 years old, apparently used to simulate the motions of the planets, were found in 1902 in the remains of a ship off the island of Antikythera. The gears of the machine indicate amazing technical ability and knowledge. Later calendrical calculators, which were usually of the type in which two or more flat disks were rotated about the same axis, came to include a means of telling time at night by visually aligning part of the Big Dipper with the pole star.

Trigonometric calculators, working on a graphical principle, were in use in the Arabic period. Such calculators were used mainly to determine triangular relationships in surveying. The popularity of this device was renewed in 14th Century Europe; in fact, calculating aids of all kinds grew rapidly in popularity as well as in scope from this time onward, largely due to the difficulty of the current arithmetic techniques. Napier was continually seeking ways to improve computational methods through his inventions. One such invention, "Napier's bones," consisted of a number of flat sticks similar to the kind now used in ice cream bars. Each stick was marked off into squares containing numbers. To perform calculations, the user manipulated the sticks up and down in a manner reminiscent of the abacus. Of particular interest is the fact that Napier's invention was used for general calculation at a time when many other devices were used for the specific determination of one measurement, such as the volume of liquid in a partly full barrel, or the range of an artillery shot.

Pascal invented and built what is often called the first real calculating machine in 1642 (shown in photo 2). The machine consisted of a set of geared wheels arranged so that a complete revolution of any wheel rotated the wheel to its left one tenth of a revolution. Digits were inscribed on the side of each wheel. Additions and subtractions could be performed by the rotation of the wheels; this was done with the aid of a stylus. Pascal's calculator design is still widely seen in the form of inexpensive plastic versions found in variety stores.

In 1671 Leibniz invented a machine capable of multiplication and division, but it is said to have been prone to inaccuracies.

The work of Pascal, Leibniz, and other pioneers of mechanical calculation was greatly facilitated by the knowledge of gears and escapements gained through advances in the clock. In the 13th Century, a clock was devised for Alfonso X of Spain which used a falling weight to turn a dial. The weight was regulated by a cylindrical container divided into partitions and partly filled with mercury. The mercury flowed slowly through small holes in the partitions as the cylinder rotated; this tended to counterbalance the weight. By the 15th Century, the recoil of a spring regulated by an escapement had made its appearance as a source of motive power. Gear trains of increasing complexity and ingenuity were invented. Clocks could now strike on the hours, have minute and second hands (at first on separate dials), and record calendrical and astronomical events. Gears opened the door to wonderful automata and gadgets such as the Strasbourg clock of 1354. This device included a mechanical rooster which flapped its wings, stretched its metal feathers, opened its beak and crowed every day at noon. Later, important improvements in timekeeping included Galileo's invention of the pendulum; and the accurate driving of a clock without weights or pendulum which led to the portable watch.

Although mechanical and machine shop techniques still had a long way to go (consider the 19th Century machinist's inability to fit a piston tightly into a cylinder), the importance of mechanical inventions as aids to computation was overshadowed by electrical discoveries beginning with the invention of the battery by Volta in 1800.

During the 1700s, much experimental work had been done with static electricity. The so-called electrical machine underwent a number of improvements. Other electrical inventions like the Leyden jar appeared, but all were based on static electricity which releases very little energy in a very spectacular way. In 1820, following Volta's discovery, Oersted recognized the principle of electromagnetism that allowed Faraday to complete the work leading to the dynamo, and eventually to the electric motor. It was not until 1873, however, that Gramme demonstrated a commercially practicable direct current motor in Vienna. Alternating current (AC) was shown to be the most feasible type of electric power for distribution, and subsequently the AC motor was

GAMES COMPUTERS PLAY

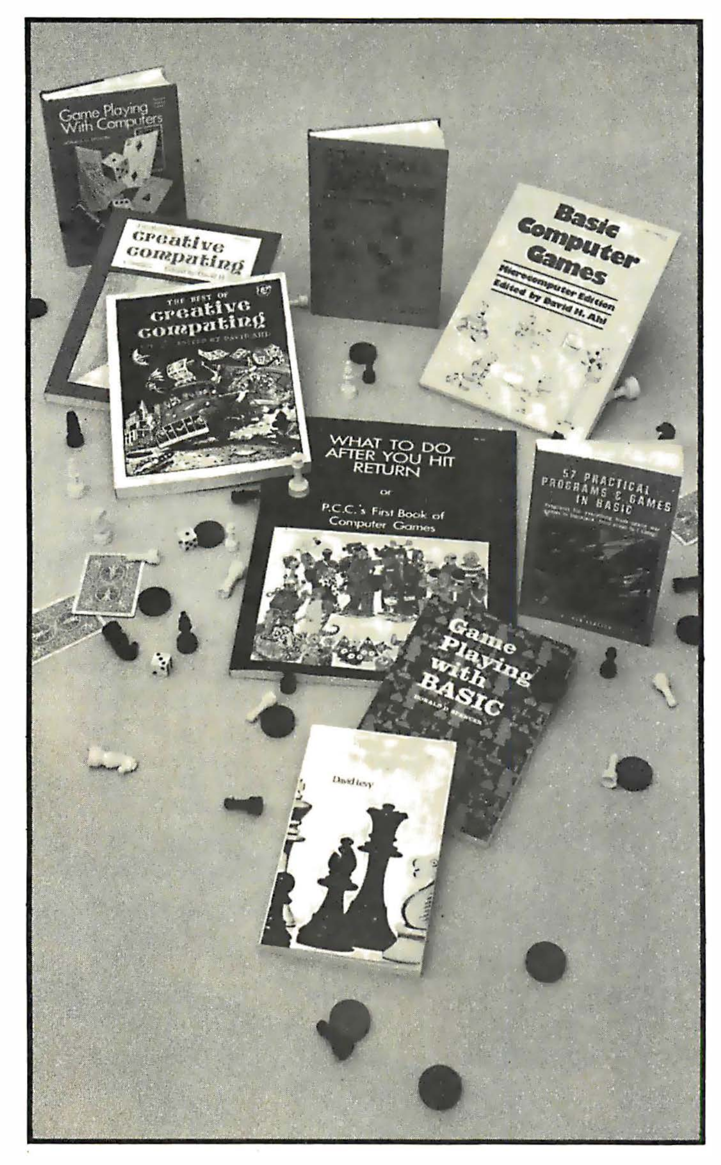
____**Chess Skill in Man and Machine** edited by Peter W Frey. This is a most challenging book, concerning itself with the when, how, and why of computer chess. 217 pp. $14.80 hardcover.

____**Game Playing with Computers** by Donald D Spencer. Read this book for an introduction to numerous recreational uses of the computer. Topics include mathematical problems, casino games, board games, unusual gambling games, and logic games. Many BASIC language programs and listings are included to show details. 312 pp. $16.95 hardcover.

____**What to do After You Hit Return or PCC's First Book of Computer Games.** This is PCC's first book of computer games, a compendium of computer games, including listings of 37 selected BASIC games. 170 pp. $8.00.

____**BASIC Computer Games: Microcomputer Edition** edited by David H Ahl. Here are 102 classic computer games, every one in standard microcomputer BASIC; every one complete with large legible listing, sample run and descriptive notes. All the classics are here: Super Star Trek, Football, Blackjack, Lunar Lander, Tic Tac Toe, Nim, Life and Horserace. This revision of **101 BASIC Computer Games** is a must even if you own the original. 185 pp. $7.50.

____**The Best of Creative Computing Volume I.**
____**The Best of Creative Computing Volume II**
Culled from the pages of *Creative Computing* Magazine, these two volumes provide fiction, fun, foolishness, and plenty of nuts and bolts commentary and programming information for anyone curious or serious about the wonderful world of personal computing. $8.95 per volume.



For your convenience in ordering, please use this page plus the order form on page 83. You may photocopy this page if you wish to keep your BYTE intact.

Just Arrived:

____**Chess and Computers** by David Levy. If you enjoy playing chess, then you will thoroughly enjoy **Chess and Computers.** This 145-page book is loaded with chess games played by and with computers. When you settle down with this book, it would be a good idea to set up your chess board and play the games. Half the enjoyment is found in playing along, duplicating the moves, reading the comments by the author and adding your own comments. $8.95.

____**Game Playing With BASIC** by Donald D Spencer lets you enjoy the challenge of competing with your own computer. Games described include: 3D Tic Tac Toe, Nim, Roulette, Slot Machines, Magic Squares, Keno, Morra, Baccarat, Knight's Magic Tour, and many others. The style is nontechnical, and each section gives complete rules for the game, how it works, illustrative flowcharts, and example outputs for each program. The last chapter contains 26 games for reader solution, including Hexapawn and Poker Dice. 166 pp. $6.95.

____**57 Practical Programs and Games in BASIC** by Ken Tracton is just that: a collection of practical BASIC applications programs for experimenters, students and professionals. In addition to the more conventional programs, there are several unusual ones (Hydrocarbon Combustion, Interactive Growth Patterns, Vector Cross Product, and Pi-Network Impedance Matching, to name a few). The book includes many flowcharts and diagrams to augment the text and programs. 204 pp. $7.95.

CALL BANK CARD ORDERS TOLL FREE **1-800-258-5477.**

BITS T.M. **The Microcomputer Bookstore**
25 Route 101 West, Peterborough NH 03458

Circle 35 on inquiry card.

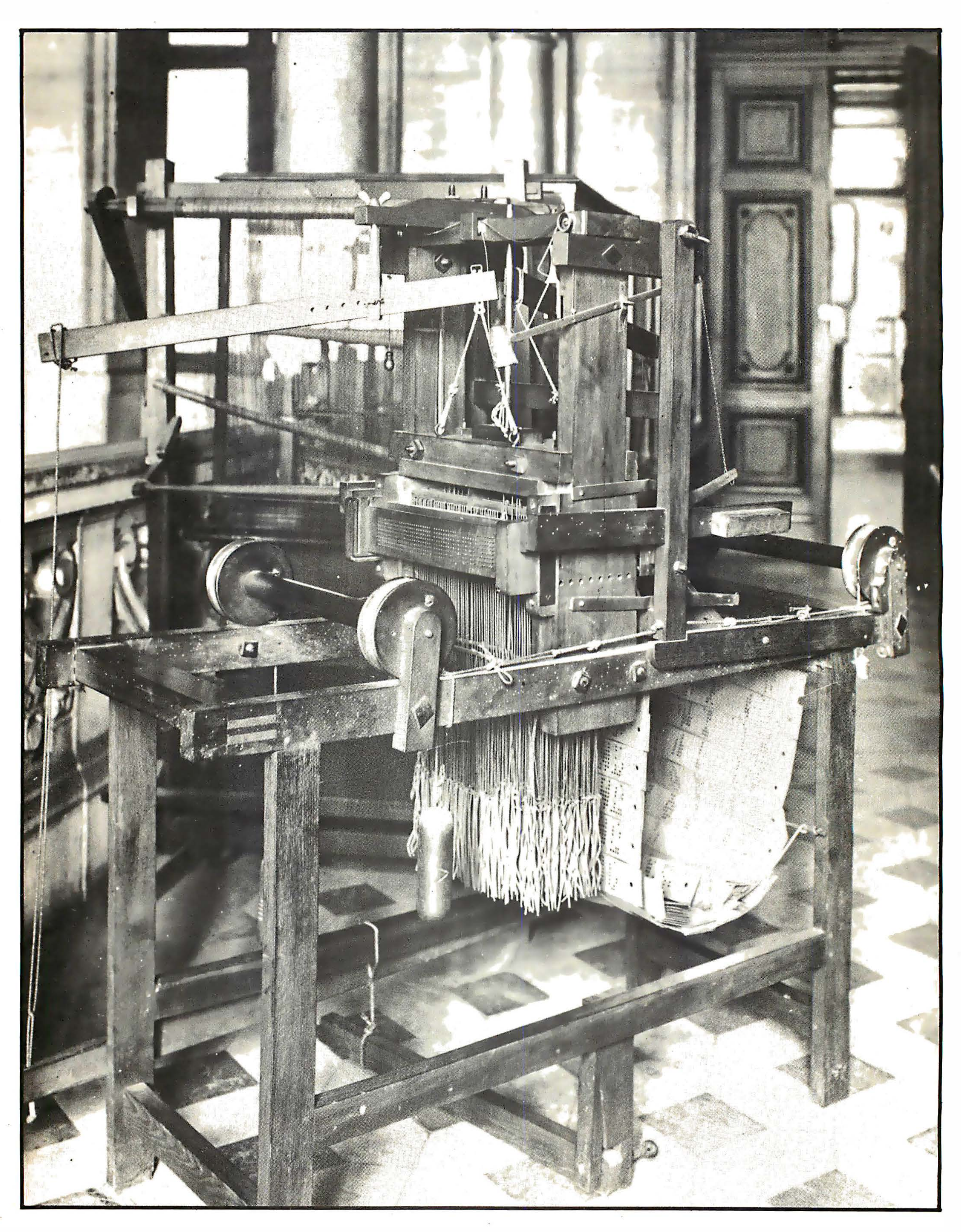


Photo 3: The Jacquard loom, one of the first machines to use holes punched in cards to control its actions.

invented in 1888 by Tesla. The value of electric power for transportation was quickly recognized and employed in tramways and electric railways. This led to improvements in methods for controlling electricity. Electric lighting methods sprang up like weeds during the latter half of the 19th Century. The most successful were due to the efforts of Swan in England and Edison in the United States. Work on electric lighting, the telegraph and the telephone led to the wonder of the age: radio. In 1895, Marconi transmitted a radio message over a distance of one mile, and six years later from England to Newfoundland.

As a consequence of the rapid growth of interest in the radio, much work was done on the vacuum tube. Lee de Forest discovered the principle of the triode in 1907. Until the development of the transistor, the vacuum tube was the most important device in computer technology due to its ability to respond to changes in electrical voltage in extremely short periods of time. The cathode ray tube, invented by William Crookes, was used in computers for a few years prior to 1960. It faded temporarily from view but returned in 1964 due to advances in technology that improved its economic feasibility as well as its value as a display tool. In 1948 Bardeen, Brattain and Shockley developed the transistor, which began to replace the vacuum tube in computers in 1959. The transistor has many advantages over the vacuum tube as a computer component: it lasts much longer, generates much less heat, and takes up less space. It therefore replaced the vacuum tube, only to fall prey in turn to microminiaturization. Of course, the transistor principle didn't go away, but the little flying saucers with three wires coming out of their bases did.

Oddly enough, one of the most fundamental devices in the early history of computing predates the electronic computer by more than two hundred years. The punched card was first used to control patterns woven by the automatic loom. Although Jacquard is commonly thought to have originated the use of cards, it was actually done first by Falcon in 1728. Falcon's cards, which were connected together like a roll of postage stamps, were used by Jacquard to control the first fully automatic loom in France, and later appeared in Great Britain about 1810 (see photo 3). At about the same time, Charles Babbage began to devote his thinking to the development of computing machinery. Babbage's first machine, the Difference Engine, shown in photo 4, was completed in 1822 and was used in the computation of tables. His attempts to build a larger Difference Engine were unsuccessful, even though he spent £23,000 on the project (£6,000 of his own, and £17,000 of the government's).

In 1833 Babbage began a project that was to be his life's work and his supreme frustration: the Analytical Engine. This machine was manifestly similar in theory to modern computers, but in fact was never completed. During the forty years devoted to the project, many excellent engineering drawings were made of parts of the Analytical Engine, and some parts of the machine were actually completed at the expense of Babbage's considerable personal fortune. The machine, which was to derive its motive power from a steam engine, was to use punched cards to direct its activities. The Engine was to include the capability of retaining and displaying upon demand any of its 1000 fifty-digit numbers (the first suggestion that a computing machine should have a memory) and was to be capable of changing its course of action depending on calculated results. Unfortunately for Babbage, his theories

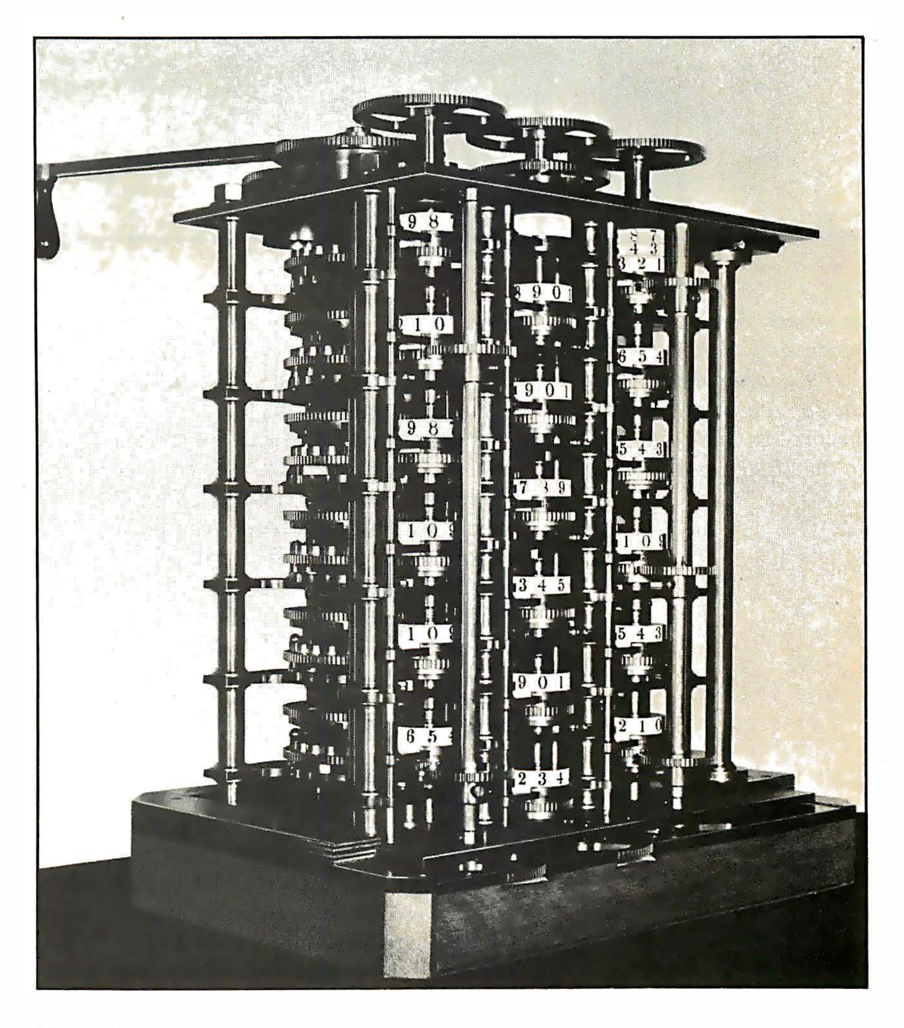


Photo 4: The Babbage Difference Engine.

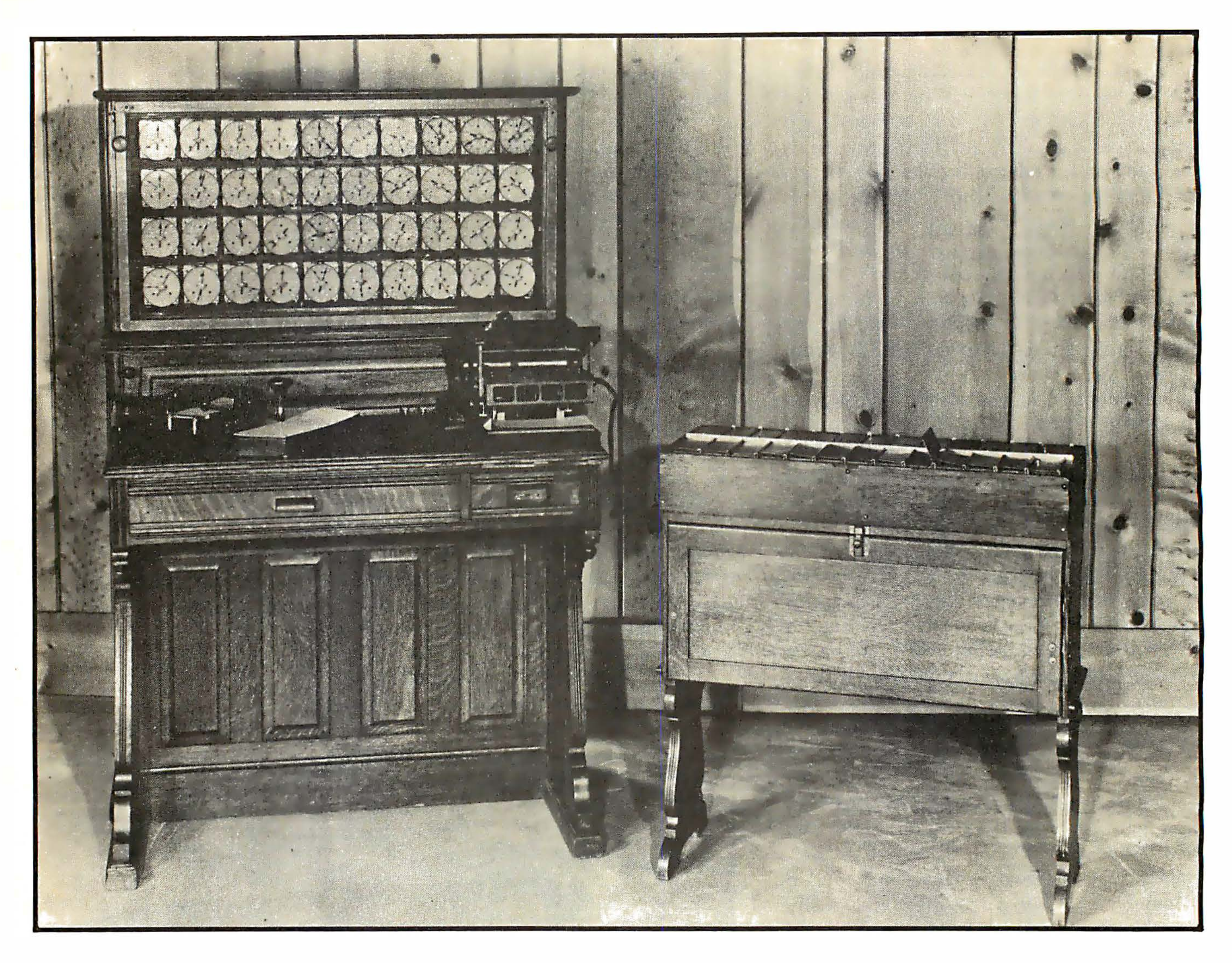


Photo 5: The first use of punched cards for data processing, Hollerith's card sorter dramatically reduced the time required to process data collected in the 1890 census.

were years ahead of existing engineering technology, but he contributed to posterity the idea that punched cards could be used as inputs to computers.

Herman Hollerith put punched cards to use in 1890 in his electric accounting machines, which were not computers, but machines designed to sort and collate cards according to the positions of holes punched in the cards (see photo 5). Hollerith's machines were put to effective use in the United States census of 1890.

In 1911, the Computing-Tabulating-Recording Company was formed, which changed its name to International Business Machines in 1924. In the period between 1932 and 1945 many advances were made in electric accounting machines, culminating in 1946 with IBM's announcement of the IBM 602 and 603 electronic calculators, which were capable of performing arithmetic on data punched onto a card and of punching the result onto the same card. It was Remington Rand, however, who announced the first commercially available electronic data processing machine, the Univac I, the first of which was delivered to the US Census Bureau in 1950. In 1963, just thirteen years after the beginning of the computer business, computer rental costs in the United States exceeded a billion dollars.

Univac I was not the first computer, even though it was the first to be offered for sale. Several one of a kind computers were built in the period between 1944 and 1950 partly as a result of the war. In 1939 work was begun by IBM on the Automatic Sequence Controlled Calculator, Mark I, which was completed in 1944 and used at Harvard University (see photo 6). Relays were used to retain numbers; since relays are electromechanical and have parts that actually move, they are very slow by modern standards.

In 1943, Eckert, Mauchly and Goldstine started to build the ENIAC (Electronic Numerical Integrator and Calculator), which became the first electronic computer using vacuum tubes instead of relays (see photo 7). The next year John von Neumann

became interested in ENIAC and by 1946 had recognized a fundamental flaw in its design. In "Preliminary Discussion of the Logical Design of an Electronic Computing Instrument," von Neumann pointed out the advantages of using the computer's memory to store not only data but the program itself. Machines without stored program capabilities were limited in scope, since they had to be partly rewired in order to solve a new problem (as was the case with ENIAC). This process sometimes took days during which time the machine could not be used. If rewiring of such machines was to be avoided, instructions had to be entered and executed one at a time, which greatly limited the machine's decision making capabilities. Machines with stored program capabilities automatically store not only numeric data but also the program (which looks like numbers and can be treated like numbers) in memory. In short, stored program instructions can be used to modify other instructions, a concept that leads to programs which can modify themselves. It is the von Neumann stored program concept which is universally used in modern computers from the smallest microcomputer to the largest number crunchers.

The growth of the missile industry in the 1950s greatly stimulated the progress of computers used for scientific work. The nature of missile data handling at that time was such that work loads were very high during the week or so after a firing and virtually nonexistent in between. Computers were too expensive to leave idle, which led managers to look for other work for the machines. Business data processing grew from these roots to its present status, accounting for the lion's share of machine usage today.

The latter part of 1959 saw the arrival of the transistorized computer. As a consequence of this innovation, air conditioning and power requirements for computers were reduced. Several new computers in that year were announced by IBM, Control



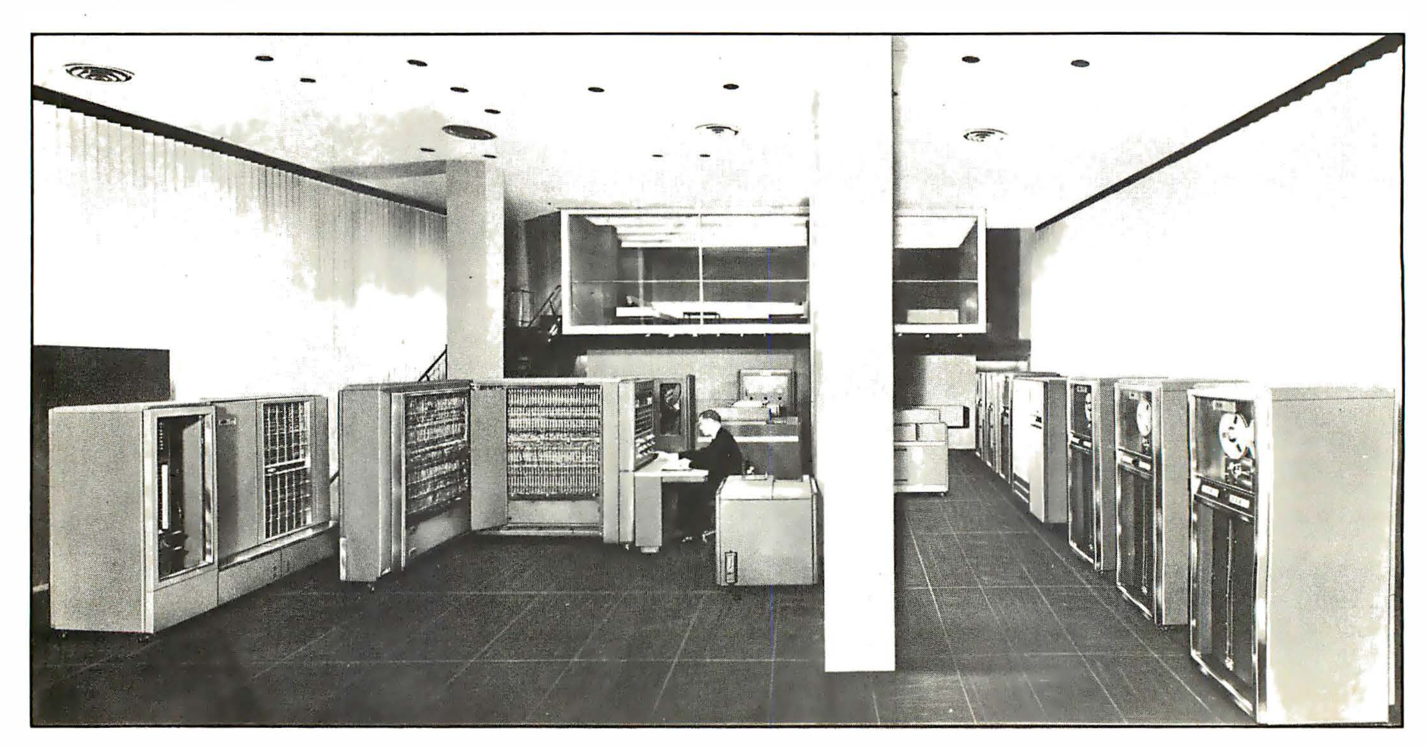
Photo 6: IBM's Automatic Sequence Controlled Calculator (ASCC), the Mark I, built at Harvard between 1939 and 1944.



Photo 7: In 1943, Eckert, Mauchly, and Goldstine started to build the ENIAC, Electronic Numerical Integrator and Calculator, which became the first electronic computer to use vacuum tubes instead of electromechanical switches.

Data Corporation, General Electric, and other manufacturers. Among the IBM announcements were the 7070 general purpose computer; the 7090, a high speed computer designed for a predominance of scientific work; the 1401, a relatively inexpensive computer aimed at the medium sized business and the 1620, a low priced scientifically oriented computer. The fantastic growth of the computer field continued through 1961 and 1962 with the announcement of more than 20 new machines each year. In 1963, continuing the family line from the grandfather 704 (as shown in photo 8), the IBM 7040 was announced. This machine embodied many of the features of the 7090 at a reduced cost. In the same year at least 23 other computers were announced by several different manufacturers. In 1964, IBM announced the 7010, an enlarged and

Photo 8: The IBM 704 had a core memory capacity of 32 K words with 36 bits per word. Although a card reader, punch, printer, magnetic tape drives and drums and a video display were available as peripherals, the concept of simultaneous IO and processing was not yet developed.



OSBORNE & ASSOCIATES, INC.

The World Leaders In Microprocessor Books

If you want information on microprocessors, begin with the Osborne books.

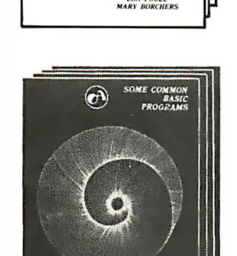
★ New prices apply to orders postmarked after June 30, 1978

PROGRAM BOOKS WRITTEN IN BASIC

Payroll With Cost Accounting
Accounts Payable And Accounts Receivable
General Ledger

These books may be used independently, or implemented together as a complete accounting system. Each contains program listings, user's manual and thorough documentation. Written in an extended version of BASIC.
#22002 (400 pages), #23002*, #24002*
$15.00 ($12.50 prior to July 1, 1978)

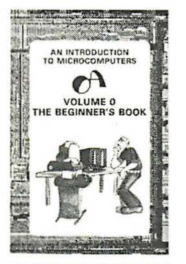
Some Common BASIC Programs



76 short practical programs, most of which can be used on any microcomputer with any version of BASIC. Complete with program descriptions, listings, remarks and examples.
#21002 (200 pages)
$8.50 ($7.50 prior to July 1, 1978)

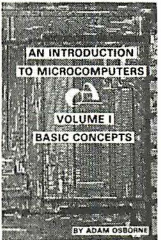
AN INTRODUCTION TO MICROCOMPUTERS

Volume 0 - The Beginner's Book



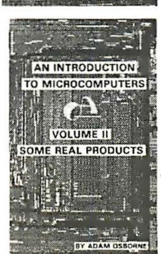
If you know nothing about computers, then this is the book for you. It introduces computer logic and terminology in language a beginner can understand. Computer software, hardware and component parts are described, and simple explanations are given for how they work. Text is supplemented with creative illustrations and numerous photographs. Volume 0 prepares the novice for Volume I. #6001 (300 pages)
$7.95 ($7.50 prior to July 1, 1978)

Volume I — Basic Concepts



This best selling text describes hardware and programming concepts common to all microprocessors. These concepts are explained clearly and thoroughly, beginning at an elementary level. Worldwide, Volume I has a greater yearly sales volume than any other computer text.
#2001 (350 pages)
$8.50 ($7.50 prior to July 1, 1978)

Volume II — Some Real Products (revised June 1977)



Every common microprocessor and all support devices are described. Only data sheets are copied from manufacturers. Major chip slice products are also discussed.
#3001A (1250 pages)
$15.00 (no change in price)

ASSEMBLY LANGUAGE PROGRAMMING

8080A/8085 Assembly Language Programming
6800 Assembly Language Programming



These books describe how to program a microcomputer using assembly language. They discuss classical programming techniques, and contain simplified programming examples relevant to today's microcomputer applications.
#31003, 32003 (400 pages each)
$8.50 each ($7.50 prior to July 1, 1978)

PROGRAMMING FOR LOGIC DESIGN

8080 Programming For Logic Design
6800 Programming For Logic Design
Z80 Programming For Logic Design



These books describe the meeting ground of programmers and logic designers; written for both, they provide detailed examples to illustrate effective usage of microprocessors in traditional digital applications.
#4001, #5001, #7001 (300 pages each)
$8.50 each ($7.50 prior to July 1, 1978)

OSBORNE & ASSOCIATES, INC. • P.O. Box 2036 • DEPT. I10 • Berkeley, California 94702 • (415) 548-2805 TWX 910-366-7277
9:00 a.m. - 5:00 p.m. Pacific Time

See prices above	PRICE	QTY	AMT
6001 Volume 0— The Beginner's Book	$		
2001 Volume I — Basic Concepts			
3001A Volume II — Some Real Products (1977 edition)			
4001 8080 Programming For Logic Design			
5001 6800 Programming For Logic Design			
7001 Z80 Programming For Logic Design			
31003 8080A/8085 Assembly Language Programming			
32003 6800 Assembly Language Programming			
21002 Some Common BASIC Programs			
22002 Payroll With Cost Accounting			
TOTAL			
Sales Tax (Calif. residents only)			
Shipping Charges			
TOTAL AMOUNT ENCLOSED			

6½%, SF Bay Area residents only
6%, California residents outside SF Bay Area
Payment by check or money order must be enclosed for orders of 10 books or less.

NAME
ADDRESS
CITY STATE ZIP PHONE

SHIPPING CHARGES

- ☐ 4th class $0.35 per book (allow 3-4 weeks within U.S., not applicable to discounted orders)
- ☐ $0.75 per book, UPS (allow 10 days) in the U.S.
- ☐ $1.50 per book, special rush shipment by air in the U.S.
- ☐ All foreign orders, $3.00 per book for air shipment

Shipping for large orders to be arranged.

*These books are scheduled to be published during 1978.
Please notify me when they are available:
- ☐ 23002 Accounts Payable and Accounts Receivable
- ☐ 24002 General Ledger

Please send information on:
- ☐ Becoming an O&A dealer
- ☐ School discounts
- ☐ List of foreign distributors

F8

Circle 293 on inquiry card.

faster version of the 1410, and the 360, which came in many different sizes and embodied many features not found in previous computers. Control Data Corporation announced the 6600, and General Electric their 400 series. The IBM 360/370 is typical of a trend in computer manufacturing which is currently followed by most manufacturers: upward compatibility. In the years prior to 1965, every manufacturer spent huge sums of money on research and programming support for several types of computers; several went out of business doing so. Likewise, computer users spent a lot of money to develop their systems for a particular computer only to find it had been superseded by a faster, less expensive machine. As a consequence, the deadly management decision of the period was, "Do we get the cheaper machine and spend the money on reprogramming, or do we risk staying with an obsolete computer and losing our programmers to the company across the street?"

Current developments point to a new trend away from the bigger machines. The combination of lower prices for components and programmable read only memories is attracting many manufacturers to the field of minicomputers and microcomputers. The current trend is clearly toward the personal computer, with TV game microprocessors leading the way.■



Photo 9: Cray Research Inc has recently introduced their entry into the field of supercomputers, the Cray-1, which can perform between 20 million and 60 million floating point calculations per second.

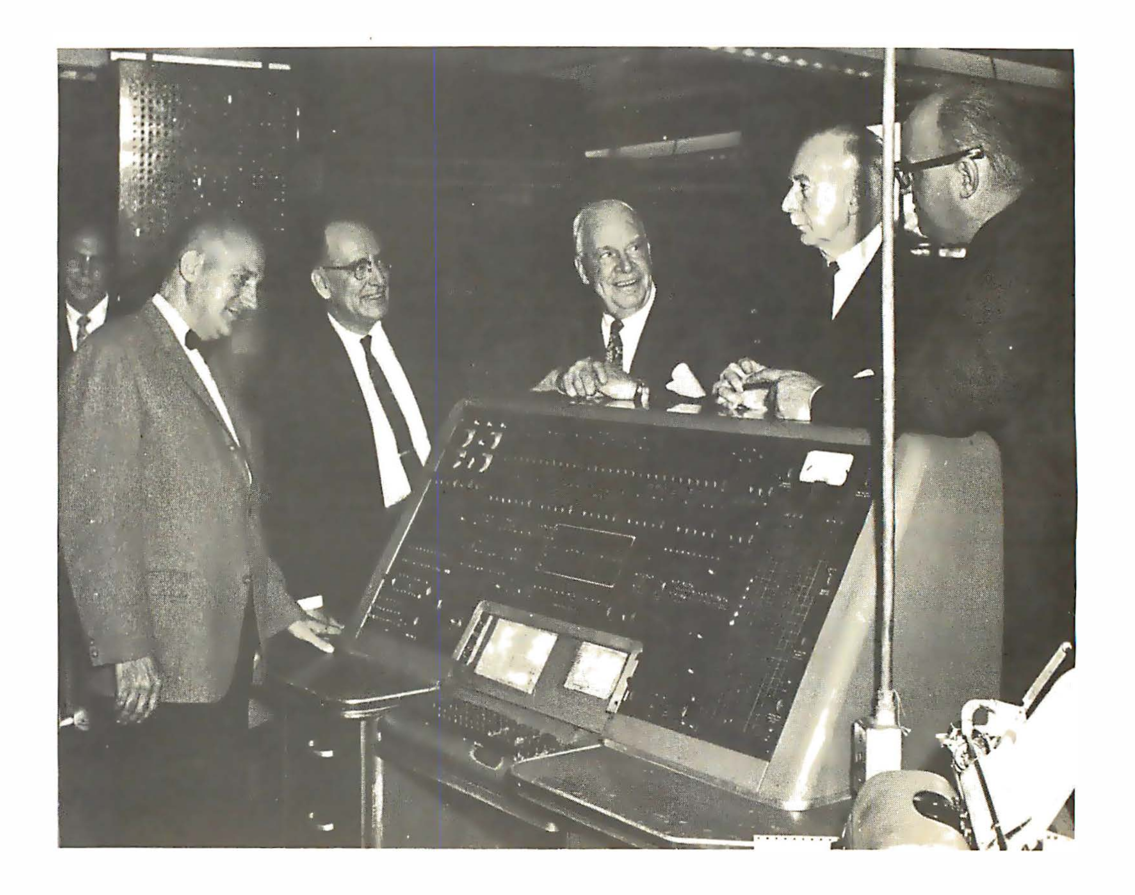
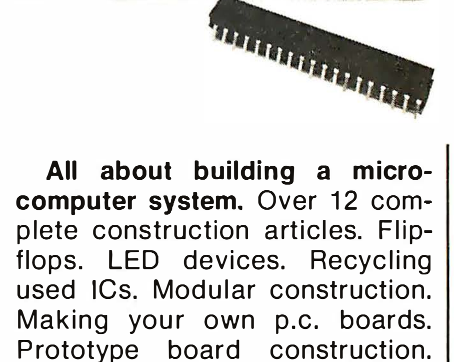


Photo 10: The UNIVAC I computer system was the first commercial computer produced by Remington Rand (now the Sperry Univac division of Sperry Rand Corporation). The first UNIVAC I was supplied to the United States Bureau of the Census in March 1951. It was the first computer to be equipped with extensive peripheral equipment.

Everything you've ever wanted to know about microcomputers in ONE complete book for only $10.95

Over 400 pages. Full 8½" x 11" size.



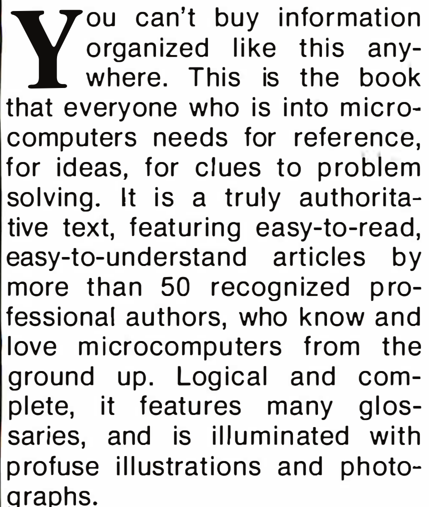
The ultimate book about microcomputers. Written by experts . . . SCELBI and BYTE. Over 400 pages. A collector's item, featuring The Basics from the first 16 issues of BYTE and SCELBI's classic library of books. Your microcomputer bookshelf is incomplete without this priceless edition.

You can't buy information organized like this anywhere. This is the book that everyone who is into microcomputers needs for reference, for ideas, for clues to problem solving. It is a truly authoritative text, featuring easy-to-read, easy-to-understand articles by more than 50 recognized professional authors, who know and love microcomputers from the ground up. Logical and complete, it features many glossaries, and is illuminated with profuse illustrations and photographs.

The Scelbi/BYTE Primer is divided into four logical sections, that take you from point "0" through building and programming your own computer . . . step-by-step-by-step.

What can you do with a microcomputer? Checkbook balancing. Recipe converting and food inventory. Heating and air conditioning control. Home and business security and management. Playing the ponies. Analysis of the stock market. Maintaining massive data banks. Self-instruction. Toys and games. Small business accounting and inventory. And lots, lots more.

How does a microcomputer do it? Lots of "how to" theory. Introducing you to microcomputer operation. 6800, 6502, Z80 CPU chip capabilities. RAM and ROM memories. Addressing methods.



THE SCELBI/BYTE PRIMER

Over 400 pages. Selected articles from BYTE and SCELBI books. Profusely illustrated. Many photographs. $10.95, plus $1 shipping and handling.

How to control peripherals. Transmission of information to and from computers. Magnetic recording devices for bulk storage. Analog to digital conversion. How a computer can talk. Other I/O techniques. And more.

Order your copy today!

SCELBI COMPUTER CONSULTING INC.
Post Office Box 133 PP STN
Dept. B
Milford, CT 06460

BITS
70 Main Street
Peterborough, NH
03458
1-800-258-5477

Prices shown for North American customers. Master Charge. Postal and bank Money Orders preferred. Personal checks delay shipping up to 4 weeks. Pricing, specifications, availability subject to change without notice.

All about building a microcomputer system. Over 12 complete construction articles. Flip-flops. LED devices. Recycling used ICs. Modular construction. Making your own p.c. boards. Prototype board construction. Make your own logic probes. Construction plans for 6800 and Z80 computers. Building plans for I/Os — TV and CRT displays, cassette interfaces, etc. Mathematics functions. ROM programmer. Plus much, much more.

How to program a microcomputer. Programming for the beginner. Assembling programs by hand. Monitoring programs. Number conversions. Game of Hexpawn. Design your own assembler. Lots more.

And that's only the beginning! Others have spent millions acquiring the type of microcomputer information found within the 400 pages of **The Scelbi/BYTE Primer.** But, it costs you only $10.95, plus $1 for postage and handling, complete! You know the quality of Scelbi and BYTE. This is your assurance of excellence throughout this MUST text. Order your copy today! And, get one for a friend!

Circle 322 on inquiry card.

Clubs and Newsletters

Conducted by David Wozmak

The Computer Hobbyist Group of North Texas

The Printed Circuit is a monthly publication of The Computer Hobbyist Group of North Texas, a nonprofit organization dedicated to the interests of the personal and hobby computer enthusiast. The officers of the club are R Neil Ferguson, president; Bill Lewis, vice-president; Dave Aos, secretary, and Ted Palmer, treasurer. Subscription to *The Printed Circuit* may be obtained by joining the group at a rate of $7 per year. Dues should be sent to Ted Palmer, 1704 Downey Dr, Fort Worth TX 76112. All correspondence regarding *The Printed Circuit* should be addressed to POB 1344, Grand Prarie TX 75051.

ACG-NJ

The Amateur Computer Group of New Jersey cosponsored the Trenton Computer Festival on April 22 thru 23. The show had an attendance of just over 2000. There were a number of presentations on items of interest to the hobbyist. The talks included such topics as beginning in personal computing, software, robotics, amateur radio, interfacing, and many special microcomputer applications. The list of speakers included Carl Helmers from BYTE, Sol Libes (ACG-NJ), David Ahl (Creative Computing), and many others.

Also featured at the festival was a flea market covering more than 5 acres, more than 40 exhibition booths, and the MSC IEEE Student Paper Finals.

ACG-NJ is a nonprofit educational corporation located in northern New Jersey. Membership is $5 per year (US and Canada) or $12 year (foreign). This fee covers a newsletter subscription. ACG-NJ can be reached by writing to the Amateur Computer Group of New Jersey, UCTI, 1776 Raritan Rd, Scotch Plains NJ 07076.

SEMCO

The Southeastern Michigan Computer Organization is a charter member of the Midwest Affiliation of Computer Clubs (MACC) and is a nonprofit, registered organization. The club has many special interest groups (SIGs) built around the various computers: SIG-6800, SIG-HUG (Heath Users Group for H8 and H11), SIG-RS (Radio Shack TRS-80), SIG-S-100 (IMSAI and Altair, S-100 bus), SIG-KIM, SIG-Digital, and also SIG-BIG, which is a group for those interested in big machines.

SEMCO puts out a newsletter, *The Data Bus,* which has an excellent format. It has

club information, and articles which are both informative and entertaining.

Membership is $10 per year and includes the newsletter. For more information write to the Southeastern Michigan Computer Organization, POB 9578, Detroit MI 48202.

Sacramento Microcomputer Users Group

SMUG meets on the fourth Tuesday of every month at 7:30 PM (July 25, August 22) on 99th St, off Hwy 50, in Sacramento. Write to SMUG for exact location or for other information at POB 161513, Sacramento CA 95816.

Alamo Computer Enthusiasts

Located in San Antonio, this group meets on the fourth Friday of each month at 7:30 PM in room 104, Chapman Graduate Center, Trinity University. Special interest groups include the Z-80, 8080, 6800, 6502, North Star BASIC, Microsoft BASIC, Teletypes, graphics, and process controllers. For more information write to the Alamo Computer Enthusiasts, 7517 Jonquill, San Antonio TX 78233.

The Apple Core

The San Francisco Apple Users Group, or the Apple Core, has been formed, and has held three meetings to date. The group was organized by Scot Kamins from San Francisco in early April 1978.

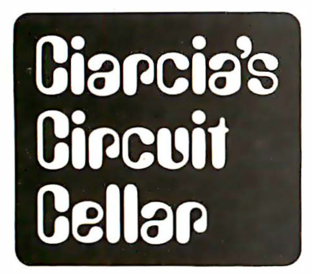
Membership regulations are somewhat exclusive; members must own or use an Apple computer. For more information contact Scot Kamins, organizer, San Francisco Apple Users Group, POB 4816, Main PO, San Francisco CA 94101.

Microprocessing Club of Gloucester County College

Located in Sewell NJ, the Microprocessing Club of Gloucester County College is now up and running. Membership is open to students of GCC and honorary membership is open to all (however, honorary members cannot vote). To find out more about this club contact Mike Seiler, Microprocessing Club, Gloucester County College, Tanyard Rd, Sewell NJ 08080.

NECS

The New England Computer Society meets monthly at the Mitre Corp cafeteria, Bedford MA. For information write to the New England Computer Society, POB 198, Bedford MA 01730.■



Build a Keyboard Function Decoder

Steve Ciarcia
POB 582
Glastonbury CT 06033

"Dear, when you go downstairs would you turn the printer on for me?"

My wife Joyce was on her way to the basement with an armload of photographic supplies. "And could you see if I turned the video display off as well?"

I was reclining in an overstuffed chair with the keyboard in my lap. Joyce stopped at the doorway and said, "Who was your last servant?"

"Please do it for me, honey," I said, chastened. "I have papers all over my lap and you wouldn't want me to spill my martini, would you?"

"Hey, kid, I thought computers were supposed to make life easier for us poor folk."

"They do! It's the peripherals that don't."

The next logical question I asked myself was: why shouldn't turning the printer or recorder on and off be as easy to do as any other computer transaction? A couple of quick solutions came to mind. One is to install an intercom system and station a person next to the computer while the remote terminal is in operation.

A second and more practical alternative is to put long extensions on the power lines of your peripherals and apply power to them from a remote location, but this means rewiring your house if the computer is downstairs and the terminal is upstairs (as in my case).

The third and probably best approach is to use some of the unused functions on your keyboard to control peripherals remotely. There are a number of unprinted characters on a keyboard such as: end of transmission, end of text, or device control codes. By attaching an ASCII decoding circuit to monitor the line between the keyboard and the computer, these functions can be isolated and utilized as peripheral device control signals — more about this later.

The ASCII Code

Most keyboards use ASCII coding, a 7 bit binary code with an eighth bit sometimes added for parity checking. (Here we ignore the proposed extensions to the officially defined ASCII code which makes it a true 8 bit code or nine bits with parity.) A complete list of ASCII codes is outlined in "Complete ASCII" by Dave Ciemiewicz (February 1978 BYTE, page 19). When your computer program is executing and awaiting data from the keyboard, a special keyboard input routine is usually activated in the program. The subroutine first determines whether a key has been pressed by checking for a key-pressed strobe signal. On systems that do not check parity (and thus use only 7 bit ASCII), the eighth bit of an input port is often set as the strobe bit. The other seven bits are not considered unless this strobe bit is "true." When this is the case, the seven bits are compared to a valid entry table within the program to determine what to do with the input. If there is no valid comparison, the input key does nothing.

The software read and compare routine is analogous to a hardware address decoder. For a particular ASCII code like CONTROL R hexadecimal 12, a circuit such as that in figure 1 could be used to decode and identify only this particular code. For routine uses such as a hardware reset, this is the way many computer experimenters decode an ASCII code. This basic circuit can be duplicated many times to decode other codes. Figure 2 illustrates how this approach can enable a CONTROL R to turn on a device

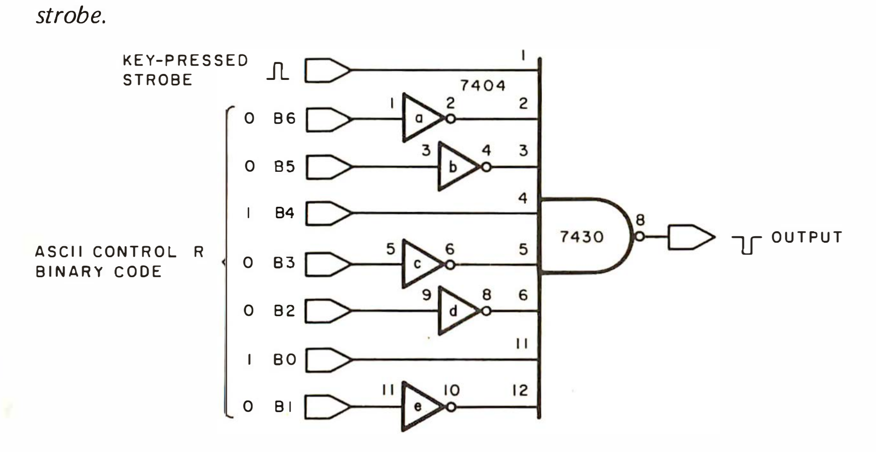


Figure 1: Sample hardware circuit to decode a single control code (in this case, CONTROL R). The pulse output width is the same as that of the key pressed strobe.

Wait No Longer!

The new educational programs are here.

Discover how to get more out of your computer.

Magnemedia has produced the innovative line of software products you've been waiting for. Designed for use both at home or in the classroom, these programs make learning an exciting experience.

This software comes in handsome two-cassette albums. Each cassette provides voice instruction on one side and a machine readable code on the other. Separate instruction booklets are provided in non-technical language.

All software is for APPLE II. Programs available for other micro computers indicated by following key:

★RADIO SHACK TRS-80 (Level II)

☆COMMODORE PET

✔HEATH H8 (Extended Basic)

Programs Now Available

- **Quiz Baseball** (16K)—An exciting game for two teams or players, using your questions. Computer simulates action, totaling batting averages and scores.
- **Save-A-Sketch**™(8K)—Create a colored picture with your computer keyboard. Save it for your gallery or use it as an illustration in another computer program.
- **Save-A-Story**™ (16K)—Write or copy a story for practice in typing, speed reading, or for storage in your computer library.
- **Learning Basic** (16K)—A package of two cassettes with multiple programs. Learn programming the easy way—let the computer teach you.
- **Mystery Word**™(8K)—Develop your logic skills by guessing the secret word. Computer tells you how many letters are correct in each guess.
- **Reverse** (8K)—A challenging math game that's a real brain teaser. How many times will you have to switch the numbers to get them in proper order?
- **Supermath**™ (16K)—The computer teaches you to add, subtract, multiply and divide on your own level—in color!
- **True/False Quiz** (8K)★☆✔—Tells you how to enter your own quiz.
- **Variable Message** (8K)☆—You choose message and colors, the computer does the rest.
- **Matching Quiz** (8K)★—Three changeable categories in each program. Match item on left correctly with one on right and they both disappear.
- **Don't Fall**™ (8K)☆—The computer chooses a word—you try to guess the letters without falling off cliff. Then you give the computer a word.
- **Memory Aide** (8K)☆—Help memorizing facts, verses, lists. Computer prompts you, asks you to provide missing words, etc.
- **Study Aide** (8K)—The computer gives questions in random order. If you miss, it saves the question for a later try.
- **Keyboard Organ** (4K)—Turn your computer into a musical instrument. Play the keys like a piano!
- **Grading Routine** (16K)—Takes the drudgery out of finding class curves. Different categories, grading scales, etc.
- **Drawing** (4K)★☆✔—Computer picks word at random from list you supply.

Here's the best news of all—each package of two programs sells for only $12.00! Individual programs are available for $7.50.

Magnemedia software is in stock at computer stores everywhere. (Dealers listed below). If not available yet at your store, ask them to order for you.

Authorized Distributors

Arizona
Personal Computer Place, Mesa (602) 833-8949
Arkansas
Datacope, Little Rock (501) 666-8588
California
A-Vidd Electronics Co., Long Beach (213) 598-0444
Byte Shop, Marina Del Rey (213) 530-3860
Byte Shop, Tustin (714) 731-1686
Byte Shop Computer Store, Walnut Creek (415) 933-6253
Byte Shop No. 8, Hayward (415) 537-2983
Computerland, El Cerrito (415) 233-5010
Computerland, Lawndale (213) 371-4010
Computerland, Mission Viejo (714) 770-0131
Computerland of West L.A., Inglewood (213) 776-8080
Computers Are Fun, Los Angeles (213) 475-0566
Recreational Computer Ctrs, Sunnyvale (408) 735-7480
The Computer Store, Santa Monica (213) 451-0713
Colorado
The Byte Shop, Inc., Englewood (303) 761-6232
Connecticut
Computerland, Fairfield (203) 374-2227
Florida
Byte Shop, Miami (305) 264-2983
Georgia
Byte Shop, Atlanta (404) 255-8984
Datamart Inc., Atlanta (404) 266-0336
Computerland of Atlanta, Smyrna (404) 953-0406
Illinois
Byte Shop, Champagne (217) 352-2323
Computerland, Arlington Heights (312) 255-6488
Imperial Computer Systems, Rockford (815) 226-8200
Kansas
Personal Computer Center, Overland Park (913) 649-5942
Louisiana
Computer Shoppe, Metairie (504) 454-6600
Maryland
Computerland, Rockville (301) 948-7676
Massachusetts
The Computer Store, Burlington (617) 272-8770
Michigan
Computerland of Grand Rapids, Kentwood (616) 942-2931
New Hampshire
Computerland, Nashua (603) 889-5238
New Mexico
Interactive Computers, Santa Fe (505) 892-9997

Write to:
Magnemedia
17845 Sky Park Circle, Suite H
Irvine, CA 92714 (714) 549-9122

New Jersey
Computer Corner, Pompton Lanes (201) 835-7080
The Computer Emporium, Cherry Hill (609) 667-7555
New York
Computer Shop of Syracuse, De Witt (315) 446-1284
Computer Tree Inc., Endwell, (607) 748-1223
Computer Micro Systems, Manhasset (516) 627-3640
North Carolina
Byte Shop, Raleigh (919) 833-0210
Ohio
21st Century Shop, Cincinnati (513) 651-2111
Oklahoma
Microlithics Inc., Oklahoma City (405) 947-5646
Texas
Byte Shop, Richardson (214) 234-5955
CompuShop, Dallas (214) 234-3412
Computer Terminal, El Paso (915) 532-1777
Computerland, Austin (512) 452-5701
Computers 'n Things, Austin (512) 453-5970
Interactive Computers, Houston (713) 486-0291
Interactive Computers, Houston (713) 772-5257
Micro Computer Shop, Corpus Christi (512) 855-4516
Washington
Ye Olde Computer Shoppe, Richland (509) 946-3330
Ontario, Canada
The Computer Mart, Toronto (416) 484-9708

Circle 216 on inquiry card.

Figure 2: Printer on and off control designed with discrete logic elements. Pressing CONTROL R causes a logic signal to activate an external relay in series with the printer power line. Pressing CONTROL T resets this circuit and turns the printer off.

such as a printer, and a CONTROL T to turn it off. The method reaches a point of diminishing returns when more than one device is to be controlled, though.

Another disadvantage of this handwired decoding is that it is difficult to change the decoded value. I recently received a letter from a reader who needed a remote reset button. He built a circuit similar to the one in figure 1, and it worked fine for the software he was using at the time. But when he changed from MaxiBASIC to Zapple BASIC, he found that the control code he had chosen for reset was necessary for use in the BASIC, so out came the soldering iron and in went another integrated circuit. Then came the expansion of more software from other manufacturers, and the circuit had to be changed again. His complaint was concerned not with the method of decoding the signal but rather with the difficulty in changing its particular address.

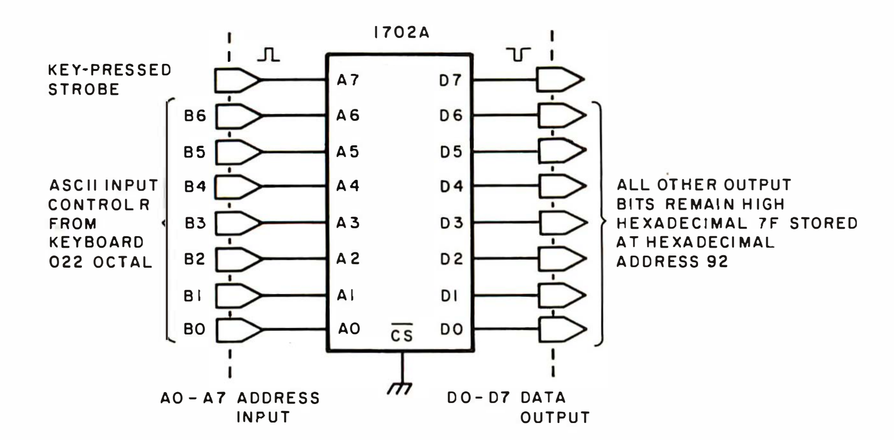


Figure 3: 1702A erasable read only memory used as an 8 bit address decoder. When CONTROL R is depressed on the keyboard, the output at D7 goes low (or true) for a period equal to that of the key-pressed strobe. This circuit can replace up to eight of the circuits shown in figure 1.

I, of course, wanted to have a hardware reset and peripheral device controller. I could build a combination of the circuits in figures 1 and 2 and hope that the next piece of software I get doesn't use one of the control codes I used, but a concept this simple shouldn't require that much wiring or make it that hard to change addresses.

Since I like the idea of using the keyboard to control the peripheral devices and don't like to solder any more than necessary, the best alternative for me is a programmable read only memory board control code decoder.

Consider how a programmable read only memory works: a binary code is impressed on the address input lines and, in the case of the 1702A, an 8 bit binary word stored at that location appears at the output. By se-

Hexadecimal	Octal	Parity	Character	Control Keyboard Equivalent	Alternate Code Names
00	000	EVEN	NUL	@	NULL,CTRL SHIFT P,TAPE LEADER
01	001	ODD	SOH	A	START OF HEADER,SOM
02	002	ODD	STX	B	START OF TEXT,EOA
03	003	EVEN	ETX	C	END OF TEXT, EOM
04	004	ODD	EOT	D	END OF TRANSMISSION,END
05	005	EVEN	ENQ	E	ENQUIRY,WRU,WHO ARE YOU
06	006	EVEN	ACK	F	ACKNOWLEDGE,RU,ARE YOU
07	007	ODD	BEL	G	BELL
08	010	ODD	BS	H	BACKSPACE,FE0
09	011	EVEN	HT	I	HORIZONTAL TAB,TAB
0A	012	EVEN	LF	J	LINE FEED,NEW LINE,NL
0B	013	ODD	VT	K	VERTICAL TAB,VTAB
0C	014	EVEN	FF	L	FORM FEED,FORM PAGE
0D	015	ODD	CR	M	CARRIAGE RETURN,EOL
0E	016	ODD	SO	N	SHIFT OUT,RED SHIFT
0F	017	EVEN	SI	O	SHIFT IN,BLACK SHIFT
10	020	ODD	DLE	P	DATA LINK ESCAPE,DC0
11	021	EVEN	DC1	Q	XON,READER ON
12	022	EVEN	DC2	R	TAPE,PUNCH ON
13	023	ODD	DC3	S	XOFF,READER OFF
14	024	EVEN	DC4	T	TAPE,PUNCH OFF
15	025	ODD	NAK	U	NEGATIVE ACKNOWLEDGE,ERR
16	026	ODD	SYN	V	SYNCHRONOUS IDLE,SYNC
17	027	EVEN	ETB	W	END OF TEXT BUFFER,LEM
18	030	EVEN	CAN	X	CANCEL,CANCL
19	031	ODD	EM	Y	END OF MEDIUM
1A	032	ODD	SUB	Z	SUBSTITUTE
1B	033	EVEN	ESC	[	ESCAPE,PREFIX
1C	034	ODD	FS	/	FILE SEPARATOR
1D	035	EVEN	GS	]	GROUP SEPARATOR
1E	036	EVEN	RS	^	RECORD SEPARATOR
1F	037	ODD	US	—	UNIT SEPARATOR

Note: To transmit any control code, depress the CTRL key while pressing the character key on the same line under Keyboard Equivalent.

Table 1: ASCII code of control characters.

lectively storing specific values at designated locations in the programmable read only memory, a single 1702A can be structured to perform the functions of eight separate decoders like the one in figure 1. For example, if a CONTROL R code were impressed on the address lines of the 1702A, and hexadecimal 7F (binary 01111111) is stored in hexadecimal address 12, the most significant output bit will go low whenever this pattern appears. All other output lines will remain at a high level. The same method can be used for eight different ASCII codes. The function of the circuit shown in figure 1 can be performed by an erasable read only memory (EROM) as shown in figure 3.

To use an EROM for this purpose, first choose eight different ASCII codes which are available on your keyboard and which are not used as software control codes. By convention, CONTROL Q, CONTROL R, CONTROL S and CONTROL T have been set aside to represent Reader On, Punch On, Reader Off and Punch Off, respectively. The other four control codes could be CONTROL W, X, Y and Z, etc. Table 1 shows the ASCII control codes.

An unprogrammed (erased) EROM has all bits set to the 1 state. This is true for the 1702A, the 2708 and the 2716. Next, choose eight control codes and make a list such as the one in table 2.

Store the binary word listed at the respective address location equivalent to the ASCII code with the eighth bit (the strobe bit) set high. For a CONTROL R, a hexadecimal 14 code, this would become an address of hexadecimal 94. When one of these particular keys is pressed, a particular output bit of the EROM goes low for the duration of the key-pressed strobe. Obviously, if only a short pulse is necessary for your control application, no further logic is necessary. In my application it is necessary to "hold" the

Table 2: Hexadecimal values to be stored in EROM to decode eight control codes.

Keyboard	Hexadecimal Code	Hexadecimal EROM Address*	Hexadecimal Value to be Stored in EROM
CTL Q	11	91	7F
CTL R	12	92	BF
CTL S	13	93	DF
CTL T	14	94	EF
CTL W	17	97	F7
CTL X	18	98	FB
CTL Y	19	99	FD
CTL Z	1A	9A	FE

Note: All other address locations should have hexadecimal FF (fully erased data) stored in them.

*The EROM address is the 7 bit ASCII code with the eighth bit set high.

state of three devices and pulse two of them. This requires latches made from external gates to maintain the control output after the initiating pulse. One method is to trigger an RS flip flop on and off with two separate codes. In this way, CONTROL R and CONTROL T can be used to turn the printer on and off, respectively. Figure 4 illustrates the completed keyboard function decoder utilizing a 1702A EROM. It allows latched on and off control of three devices and pulsed control of two more. I chose a 1702A because of its cost advantages: at $3.50 it is more appealing than a $12.50 2708; but the 2708 may be more easily programmed for most people (see "Program Your Next EROM in BASIC," March 1978 BYTE, page 84). It can be used instead of the 1702A with the appropriate pin assignment changed. Since the 2708 is a 1 K EROM and the 1702A is 256 bytes, the two extra address lines A9 and A10 should be grounded on the 2708. If you decide to use the method of figure 2 and not use an EROM to make the circuit of figure 4, it will take 14 TTL chips just to create the logical equivalent of the EROM.

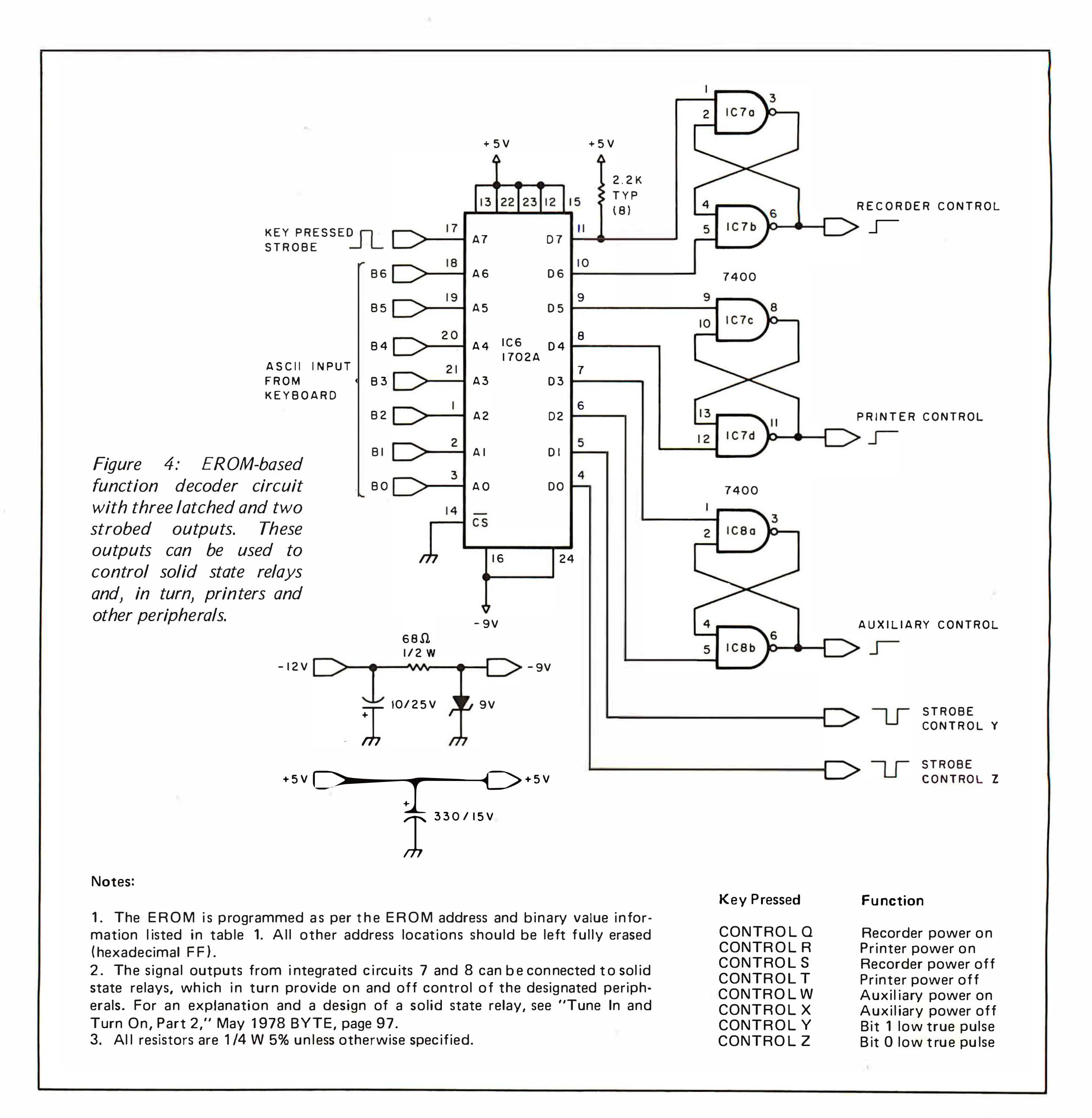


Figure 4: EROM-based function decoder circuit with three latched and two strobed outputs. These outputs can be used to control solid state relays and, in turn, printers and other peripherals.

Notes:

1. The EROM is programmed as per the EROM address and binary value information listed in table 1. All other address locations should be left fully erased (hexadecimal FF).
2. The signal outputs from integrated circuits 7 and 8 can be connected to solid state relays, which in turn provide on and off control of the designated peripherals. For an explanation and a design of a solid state relay, see "Tune In and Turn On, Part 2," May 1978 BYTE, page 97.
3. All resistors are 1/4 W 5% unless otherwise specified.

Key Pressed	Function
CONTROL Q	Recorder power on
CONTROL R	Printer power on
CONTROL S	Recorder power off
CONTROL T	Printer power off
CONTROL W	Auxiliary power on
CONTROL X	Auxiliary power off
CONTROL Y	Bit 1 low true pulse
CONTROL Z	Bit 0 low true pulse

Table 3: Power wiring table for figures 2 and 4.

Number	Type	+5 V	Gnd
IC1	7404	14	7
IC2	7404	14	7
IC3	7430	14	7
IC4	7430	14	7
IC5	7400	14	7
IC6	1702A	see schematic	
IC7	7400	14	7
IC8	7400	14	7

Some Final Thoughts

I guess I don't have to worry about finding someone to be my peripheral "slave" any more. The uses of this remote control system can be extended beyond the ones I've outlined; my horizons were limited at the time. Once I sit back in that chair with a keyboard in my lap, it takes an earthquake to move me.

Do you have any questions, comments or ideas for an article? Write to me; I try to answer every letter. Please enclose a stamped self-addressed envelope. Next month: a touch panel digitizer.■

Continued from page 6

sages sent and received would be the following little loop:

```
var
   hangup : boolean;
hangup := false;
repeat
      [look at keyboard, send latest input
       messages to line and display]
      [look at line, send any input
       messages to display]
until hangup ;
```

(This program fragment is represented in PASCAL with the use of italics enclosed in square brackets [] to denote functions described verbally but not in detail. Note that "hangup" is a dummy variable within the context of this fragment as shown.)

This simple programming model is applied at both ends of the communications line through the phone network. It might in fact be implemented in two totally different computer and software systems, say in assembly language on one party's computer and in PASCAL on the other party's computer. It also has the unfortunate disadvantage of displaying the incoming message from the line mixed with the latest outgoing message from the keyboard.

Walking through the process of establishing and holding a conversation illustrates some fundamental points which apply to any computer to computer communications method. In this case, much of the work involved in setting up the conversation, the protocol, is accomplished manually. Let's look at what a conversation between two parties might be like, using X and Y as suitable arbitrary names in this script:

Phone rings. X picks up the phone.

X: "Hello, X here."

Y: "Hi, X. Shall we proceed with the communications experiment?"

Note the implicit protocol: Y assumes X is looking for a computer to computer conversation.

X: "Sure. I'll load my program. Let me set my modem in the originate mode."

Y: "Fine. I'll set my modem in the answer mode and load my program."

Note the complementary settings of the modem modes. For a full duplex conversation, one end must be in answer mode, the other end in originate mode. A mode is simply the set of transmission and reception frequencies chosen for use by the modem from two alternatives.

X: "I'm starting my program. How's yours doing?"

Y: "Mine is just fine. Do you hear the tones from the modem?"

X: "Yes. Okay, let's try the phones."

Both parties conclude verbal communications by placing their phone handsets in the acoustic couplers. A computer to computer conversation ensues, using data from the keyboards and sending data to the displays at each end.

This is perhaps one of the simplest models of computer to computer communications over a phone line via a modem. But it illustrates a couple of important points which are required in any system which uses the dialup network.

First, there must be a protocol tying the two systems together logically. This protocol provides a method of establishing contact. Here, I used the conversation as an example due to the simplicity of the equipment and the model. It could be as complicated as a full network protocol like those of ARPA, PCNET or CIE Net. The protocol must also involve the agreement upon a functional model of the software driving the communications channel. Here the PASCAL program fragment, however it is implemented in detail, provides the common functional model for both ends of the line. The actual details of a conversation are independent of the protocol used.

Second, the equipment used at both ends must be compatible with respect to modem design. Here, I have tacitly assumed a modem is available which has one outgoing channel and one incoming channel. This could be a Bell 103 style modem which is one of the most commonly available forms on the market, or it could be some haywire kluge with nonstandard frequencies which are shared by the two parties to the conversation and nobody else. The choice of "answer" or "originate" in the context of this example is arbitrary; when using such a modem with a timesharing computer, the choice is not arbitrary.

Third, the protocol can easily be automated to some extent; with proper equipment and appropriate systems software running in your system and your network correspondent's system, the entire conversation can take place without human intervention from start to finish. But more on that subject a little later.

The conversation just described, and its protocol, are not intended as a serious suggestion for the use of a typical acoustically coupled modem. It represents if anything just a costly way to bypass the US Postal Service and all its problems and transmission delays; but then the same is true of the tele-

phone used without a computer. The interesting uses are those which take advantage of the computer at both ends of the conversation. Establishing communications between modems will involve a similar phone call scenario; but now instead of the toy program, suppose we substitute a more interesting process.

For starters, a useful utility already employed by many personal computer people is that of a file swapping program. Here, instead of keyboard input, after the communications is established and verified in a keyboard to display mode, one or the other of the two parties to the conversation accesses a local file on floppy disk and dumps it into the floppy disk of his correspondent over the phone lines. The file sent might be verified by the receiving person by one or more methods such as grouping the data into blocks with checksums or simply sending the message redundantly.

The content of the file sent by this method is arbitrary. The file could be as simple as the edited text of a letter, or as complicated as the source code of the latest version of a computer game which the receiving person is to try out, evaluate and comment upon. And of course, for the occasional business user or privacy fanatic, the program does not have to send the data directly: it could use a prime factors cipher to ensure that all the computers in the world would never be able to crack the code in practical lengths of time given our present knowledge of such ciphers and their properties.

But exchanging data files still does not exhaust the potential of having a computer at both ends of the line. What other activities involve participation by people at each end of the line? (Remember: we are still using simple modems with a manual protocol at the start of communications.) A computer at each end and a person operating the computer sounds like defining characteristics of a new class of challenging computer games.

For one degenerate case, let us suppose that each player has as his goal to "take over" the other player's computer, using a commonly defined operating system nucleus and a set of rules governing legal moves. The result would be a very abstract, possibly quite exciting (and possibly quite dull) 2 processor remote version of the classic called *core war.* [*Core war* is a game surreptitiously played by systems programmers on large installations, where a player's goal in each fixed time slice of real time is to propagate his program elsewhere in memory, while doing as much "damage" (read: clearing to zero) as possible at random places in the

hopes of causing the opponent's program to blow up.] The game of *core war* is rarely mentioned with more than a whisper, and thus tends to be lost amid the din of easier and less abstract games such as *Star Trek*, *Adventure* or *Dungeons and Dragons*. But, just as a 2 computer version of a classic is possible, these contemporary games might well be adapted to a 2 sided mode employing two computers and two teams of players.

Games border on the world of simulations, and simulations border on the world of games. The use of two local processors across the phone lines (or in the same room sans modems) has much potential. Suppose each computer is running a simulation of a plane in flight. A natural variation would be to loosely couple the state variables between the similar programs across the link, so that the two "pilots" could attempt formation flying and maneuvers. The key software which is needed is of course a simulation program with direct memory outputs to a display on each computer, and the ability to keep track of the "other guy" from the point of view of the local simulation. For most one player versus the computer games, the random number sources of data typically used could be replaced by parameters received across the communications line from the second computer. At 300 bps (30 characters per second, roughly) the potential for some 2 party interaction is definitely present, relying upon local simulations in each computer for most of the actions observed on each screen.

But enough of this blue sky. How much does the equipment cost? All of these suggestions could be implemented using a typical personal computer which has a spare serial IO port with RS-232 levels (the more floppy disk drives the better of course, with zero as the minimum acceptable number). The cost for the modem, based on two advertisements in the May 1978 issue of this magazine, would be either $139 or $129 depending upon whose modem you buy. The basics require no particular attention to the phone line itself, other than making sure you have a standard handset which fits the acoustic coupler. And of course, having made the investment you also get access to the local time sharing service, which may have such juicy tidbits as cross assemblers and compilers which are not yet up and running on your own system. But this is merely a taste of the possibilities of telecommunications: even more function can be had at a slightly higher expense through the use of modems which feature automatic dialing, automatic answering and telephone company compatible "data access arrangement" (DAA) features.

Automatic Communications:

N computers + N People + Auto Answer + Auto Dial + DAA

The protocols appropriate for an acoustically coupled modem are heavily biased by the need for manual operations. Just as the audio cassette recorder is the poor second cousin of the floppy disk as a mass storage medium, the acoustically coupled modem works for telecommunications but has many fewer features of merit than the more expensive modem options.

The first extension to consider is that of a form of the modem which is wired permanently to the phone company's network via an appropriately approved data access arrangement or DAA. Given this extension alone, there would apparently be no great improvement in function relative to the simple acoustic modem.

Thus we must consider the second extension, use of an auto answer option through the data access arrangement. Here, with appropriate software, your computer gets a signal from the interface which tells it when someone is calling. The computer can then reply with a signal which "lifts the phone off the hook" by changing appropriate electrical levels in the interface which simulate that normally manual action. The computer can then proceed to verify that there is indeed a modem on the other end and commence its automated version of that conversation between X and Y given a little earlier. For thorough description of how such protocols work, consult any text book on systems software for timesharing systems: this model is used by your friendly timesharing service to receive calls from its users with ordinary modems at the other end.

The third of these three extensions of the basic model is the auto dial function. Here the intent is to allow your computer to place the call automatically, an event which implicitly assumes the number being dialed can receive such calls unless the modem is disconnected after the call is made.

This more general function can be had at reasonable prices. The board used by Ward Christensen and Randy Suess costs about $300 assembled and tested, plugging into an S-100 bus slot. Another brand, also assembled and tested, but complete with a Bell approved data access arrangement module, runs about $500 and also plugs into an S-100 bus slot. (The difference between buying your own data access arrangement module or using a phone company version is one of paying monthly installments forever or paying a lump sum of about $100 to $150 once.)

With the economics of the auto dial and auto answer versions and data access arrangement settled, what are the possibilities which may be fulfilled? First, there is the matter of regular correspondence with a close friend on the other side of the continent. If you communicate via the simple model of the unautomated link, your prime time for originating a call may be different from the hours of prime functioning as a human being. The phone company rates are much lower in the wee hours of the morning. So, let your automated computer servant sit up late and take advantage of the cheap rates to telephone your correspondent's computer, send the mail you left for him or her and of course receive the mail left for you. More than one correspondent? Simply keep a list of phone numbers associated with the names, and call all of the ones which have been left messages on a disk file or in memory. Don't care to waste phone charges? Well, use the auto answer feature to wait for your correspondent's calls. (This concept of using the auto answer and auto dial features to implement Telemail service is one of the pet projects of Ken Bowles at the University of California at San Diego. We can expect to see a protocol established from that source, written in PASCAL of course, which will be widely available for a nominal charge.)

Let's extend the model a bit to the world of games so often frequented by the personal computer user. But now, consider the N party game, a sort of computerized version of *Dungeons and Dragons* viewed as a prototype of the N player simulation game. Now, the phone network and dialup features can be used to some advantage: instead of one week's long conversation on a party line (the brute force approach), each player node in the game has a computer with a local model of the game plus interaction models which involve dialing up other players in the game for information or to send game messages which affect the other players. To be less than prohibitive in line costs, it would have to be done locally within a "free" dialing zone of your local exchange. It is a challenging problem to even think about defining such a game, let alone playing it. It is a suggestion which is quite within the capabilities of a dedicated group of N enthusiastic participants. Who will be the first to define and implement such a discipline?

And then, of course, there is the less esoteric but quite useful concept of the local computer club bulletin board, as prototyped by Ward Christensen and Randy Suess. Here, both the auto answer and the auto dial modes can be used to advantage. The auto answer mode is of course currently being

employed in the interactive message center concept: users can call in from anywhere and leave messages which are either broadcast, or specific to particular users. The club can also prepare a file which is sent to every active user upon logging into the system.

The concepts of auto dialing and autc answering can also be applied to personal use independent of the use of the modem if provision is made to manually switch from modem data to voice data. The auto answer feature is of course typically used in a standard telephone answering machine, but by having your computer answer the line and listen with one of several voice response boards on the market, you might be able to call up your house and have various options such as lights, radios or sprinklers change state in response to voice command. If the voice recognition method of remote control does not work then consider using a touch tone telephone to send a coded pattern of numbers which are detected by another special demodulator after the phone is answered.

Auto dialing coupled with the usual voice mode enables you to build a file of frequently called numbers, a "little brown disk" instead of a little black book. These numbers could then have symbolic names like "FIRE," "MOTHER," "SUZY," "JUDY,"

etc. When a phone conversation is desired, dialing could be done symbolically by selecting a name with one character referring to a menu list on your display. Of course there are certain things one would not want to do with an auto dial feature, such as create intrusive automatically dialed junk phone calls.

Summarizing the State of the Art. . .

Computer to computer communications via the dialup phone network are a very real possibility for the personal user. The communications can be as simple and inexpensive to implement as an acoustic coupler on an ordinary telephone, or slightly more elaborate (but still less than $500 for an S-100 bus computer) with automatic answering and dialing features. However you implement your link to the outside world from a personal computer, the applications of the system expand considerably.■

How Much Is That Turtle in the Window?

As noted with a photograph and some background information on page 6 of the March 1978 BYTE, personal computer users will soon be able to add an absolutely fascinating new peripheral: an electromechanical "turtle." Recent word from Cambridge is that the Terrapin™ turtle was scheduled for a mid May press conference announcement by Terrapin Inc, 33 Edinborough St, 6th Floor, Boston MA 02111. (This note was written April 24 1978, following a phone conversation with David McClees of Terrapin.)

Using simple programming concepts in versions of the LOGO language, it is possible to teach young children many of the concepts of computer science using the mechanism of the turtle to emphasize points. Also quite possible with such a mobile robot apprendage are various other applications from delighting friends at an adult or child's party to implementing the world's least expensive plotter output using the tail dragging capability of the turtle's solenoid controlled pen. Sensors on this inexpensive robot are four microswitches which can determine one of eight possible directions when the unit runs into an object.

How much for that "turtle in the window" at your local pet store? While final prices have not yet been set, the kit version is expected to be about $300. To be complete, Terrapin Inc will also sell an assembled version for $500 or so.■



Pat Fitzgerald
Winchmore Irrigation Research Station
Private Bag
Ashburton NEW ZEALAND

BASIC to Assembly Language Linkage

Listing 1: PDP-11 assembly language listing of program to output a quotation mark.

```
        177564        TPS =177564     ;teleprinter status
        177566        TPB =177566     ;teleprinter buffer
        000050        .=50            ;link between BASIC and
                                      ;external function
000050  037426        .WORD SEXF      ;start address of
        037426        .=37426         ;external function
037426  105767  SEXF: TSTB TPS        ;is printer ready?
        140132
037432  100375        BPL  SEXF       ; if not branch
037434  012767        MOV  #042,TPB   ;move ASCII code for quotation
        000042
        140124                        ;mark to buffer and print
037442  000167        JMP  52         ;return to BASIC
        140404
        000052        .END 52
```

Listing 2: Driver program for the assembly language program in listing 1.

```
10 PRINT "IN BASIC THE QUOTATION MARK (";
20 LET T = EXF(1)
30 PRINT") IS A DELIMITER"
```

Listing 3: Sample run of the BASIC program of listing 2. This is one simple solution to the problem of printing a quotation mark in a BASIC interpreter, lacking appropriate escape mechanisms.

```
IN BASIC THE QUOTATION MARK (") IS A DELIMITER
```

Frequently one needs to use a BASIC interpreter to do things it was never designed to do. Getting around the problem can require a great deal of ingenuity. A case in point is David Chapman's article, "All This Just to Print a Quotation Mark?", in May 1977 BYTE.

Several versions of BASIC allow assembly language programs to be added to the BASIC interpreter; these programs are linked to BASIC at load time and usually cannot be deleted without reloading BASIC. Using this technique provides a very simple method of getting around the problem described by David Chapman. The assembly language listing is given in listing 1 and the BASIC language program is given in listing 2. A run of the program is in listing 3. It appears that a relatively simple solution to the problem has been found.

The version of BASIC I use is single user Digital Equipment Corporation's BASIC V008A for the PDP-11 series of minicomputers. This BASIC allows the user to call the assembly language program by use of an EXF function. Obviously in other

versions of BASIC the calling procedure will be different. The EXF function call can be used as an expression or as an element of an expression anywhere that an expression is legal in BASIC syntax.

The assembly language program is called by use of the EXF function. The argument for the quotation mark program is a dummy one and any number would suffice. However this is a trivial use of the power of the linking method. More useful programs can be written to allow BASIC to be used in a variety of applications from real time control of instruments to reading data from cassette transports. It can also be used to add powerful functions to increase the number crunching ability of BASIC. In short the uses of this tool are only limited by the user's imagination.

One particular use we can make of the assembly linkage is a program to retain a BASIC program in the machine when the power is turned off. On the PDP-11 series when BASIC is restarted, information necessary to recall the user program is lost from two of the volatile registers (although the main core memory returns its information). However, use of the assembly language program shown in listing 4 allows the contents of these registers to be saved on power down and restored at power up.

To use this program when you have temporarily finished with the BASIC pro-

Listing 4: A nontrivial use of BASIC to assembly language linkages. This PDP-11 assembly program saves the PDP-11's registers and restores them so that the program may be used after a restart occurs.

```
        000001          R1=%1          ;define registers to
        000005          R5=%5          ;be saved
        000006          SP=%6          ;register 6 to be stack
        000050          .=50
        037406          .=37406
037406  010146  START:MOV   R1,-(SP)   ;save R1 and R5
037410  010546        MOV   R5,-(SP)   ;on stack
037412  010667        MOV   SP,SAVE    ;save stack
        000016
037416  000000        HALT
                                       ;EXIT AND RE-ENTRY POINT
037420  016706  RSTRT:MOV   SAVE,SP    ;restore stack and
        000010
037424  012605        MOV   (SP)+,R5   ;registers 1 and 5
037426  012601        MOV   (SP)+,R1
037430  000167        JMP   52         ;back to BASIC
        140416
037434  000000  SAVE: .WORD 0
        000052        .END 52
```

gram, you type "Print EXF (N)" where N is an arbitrary number. When you wish to reuse the program, you start at address 037420 rather than the conventional 000000 which would destroy the user program. The machine responds by typing the number N. In this version of BASIC the linkage between the interpreter and the assembly language program is maintained through location 50; this address must contain the start address of the assembler language program. Return to BASIC is achieved by a jump to location 52. Several arguments can be used in the EXF function, but it is the user's responsibility to evaluate each argument after the first. By this technique an assembly program with several entry points can be called up from a BASIC program to do a multitude of tasks not provided for in the BASIC language.

Of course this requires that the programmer learn the assembly language. Fortunately for the PDP-11 user an excellent introductory manual has been provided by R W Southern (see references).

Moral

Try using assembly language programs before attempting complex contortions within BASIC.■

REFERENCES

Chapman, David, "All This Just to Print a Quotation Mark?", May 1977 BYTE, page 132.

Southern, R W, *PDP-11 Programming Fundamentals,* Algonquinote 12, Algonquin College Bookstore, Ontario CANADA, 1972.

Languages Forum is a feature which is intended as an interactive dialog about the design and implementation of languages for personal computing. Statements and opinions submitted to this forum can be on any subject relevant to its purpose of fostering discussion and communication among BYTE readers on the subject of languages. We ask that all correspondents supply their full names and addresses to be printed with their commentaries. We also ask that correspondents supply their telephone numbers, which will be printed unless we are explicitly asked to omit them.

Technical Forum

Fooling with the Stack Pointer

Tom Pittman
POB 23189
San Jose CA 95153

I think Dr Borrmann ("Relocatability and the Long Branch," page 26, October 1977 BYTE) used the right word when he said he was *"fooling* with the stack pointer." Using the stack pointer as a general data pointer is bad programming practice; when the system uses NMI interrupts for real time clock maintenance it is simply intolerable. In this case it is not even particularly necessary: the same two subroutines can be implemented in a stack-safe way for only eight more bytes, as follows:

```
Label    Op Code  Operand   Commentary
LONGBS   STX      XSTOR     [save X for later]
         DES                make room for copy of return
         DES
         TSX                point to it in X
         PSHA               save A on stack
         LDAA     3,X       low byte of return address
         STAA     1,X
         ADDA     #2        point to actual return
         STAA     3,X
         LDAA     2,X       high byte of return
         STAA     0,X
         ADCA     #0        finish add
         STAA     2,X
         BRA      BPUSH     skip over start of LONGBR
LONGBR   STX      XSTOR
         PSHA
BPUSH    PSHB               save b on stack
         TSX                point to top of stack in X
         LDAA     3,X       get address of offset . . .
         LDAB     2,X       . . . into A&B
         LDX      2,X       also into X,
         ADDA     1,X       so to add offset
         ADCB     0,X       to its address
         TSX                get back to stack
         STAA     3,X       put sum there
         STAB     2,X
         PULB               restore saved A&B
         PULA
         LDX      XSTOR     [restore old X]
         RET                [go to address]
```

Dr Borrman illustrated a very good idea with a poor program. However, it was a good article, bringing to people's attention the fact that the 6800 alone of all popular processors is capable of self-relocatable code. Something that Dr Borrmann perhaps did not notice is that the subroutine LONGBS (and its chain of BRA stepping stones) is superfluous. At least where the subroutines

are to be included in the program, it is probably more economical to do the subroutine calls this way:

```
         BSR    LINKn      [instead of JSR LONGBS]
         BRA    EXITn      [jump over linkage]
LINKn    BSR    LONGBR     [or JSR if LONGBR is in monitor]
         FDB    SUBR-*     [relative address of subroutine]
EXITn    . . .
```

There is also the technique of using the indexed addressing mode with JMP or JSR when X is not needed in the call itself. Once in the program you compute the address of the first of a dense block of subroutines. Then each time you need one, the following linkage is used (notice that LONGBR is not needed):

```
LDX    AFIRST          =address of first subroutine
JSR    SUB-FIRST, X
```

The easiest way to compute the address of FIRST is to jump to a BSR just before it as shown next:

```
         BRA    INIT        (part of initialization)
SAVEIT   PULA               get high byte
         STAA   AFIRST      save it in RAM
         PULA               now low byte
         STAA   AFIRST+1
         . . .              (continue with main program)
INIT     BSR    SAVEIT      push address onto stack
FIRST    . . .              (first subroutine)
```

If every subroutine knows its stack depth, you can leave the return address generated at INIT on the stack, then use the following calling sequence:

```
TSX                    point to stack
LDX    depth,X         get saved address of FIRST
JSR    SUBR-FIRST, X
```

Of course these will not work if you need the index register to pass an argument to the subroutine.■

More On Varistors: A Supplier of Some Note Comments

William G Morris
General Electric Research and Development
POB 8
Schenectady NY 12301

I don't know which brand of varistor Stephen Sorger of W N Phillips Inc (Letters, April 1978 BYTE) was using when he experienced "aging," thermal "runaway," and a "fire hazard," but it certainly was not a General Electric GE-MOV[R] varistor. As a typical example, the V130LA10 GE-MOV varistor will run at full rating to 85°C ambient, which is 15°C greater than Intel specifies as maximum temperature for the 8080. This varistor also exhibits an observed failure rate of less than 0.2% per 1000 hours during accelerated testing at 100°C ambient.

The reader should be reminded that transient suppression is essential to reliable operation of microprocessor systems, particularly in industrial environments, but also in hobby applications. Varistors continue to represent the most cost effective method of achieving transient suppression.

The V130LA10 GE-MOV varistor, which can be used directly on 110 VAC lines, is available for $1 to $2 from most industrial electronics suppliers. Additional information is available from General Electric Company, Electronics Park, Syracuse NY 13201.■

Book Reviews

Instant Freeze-Dried Computer Programming in BASIC
by Jerald R Brown
Dymax, POB 310, Menlo Park CA 94025
$6.95

How quickly the personal computer owner trades the student's notebook for the teacher's chalk. Says the friend, "Neat, you got a computer. How do you get it to do X or Y?" Or you modestly back yourself into a corner: "Programming isn't hard. I could teach you BASIC in a few hours." In my case it was a deal with my neighbor's recent high school graduate to teach him programming in return for his doing some of my more routine programming chores. But however you got the teaching job, *Instant Freeze-Dried Computer Programming in BASIC* is in my opinion an interesting, involving and entertaining text you can use to ease the teaching task.

The book resembles a half inch thick collection of BASIC oriented flashes that somehow escaped from the pages of *Ripley's Believe It or Not*. We see the scene of the keyboard LET fading into the sunset beyond the hills, captioned by "And so, in the name of Efficiency and Ease, the LET was banished forever from Statementland. . . ." Throughout each page the student is exhorted to either read the explanatory text, or, more often, "do it": the signal for you to actually type out one of the hundreds of brief examples on your waiting terminal. The layout is designed to be both a text and a practical workbook. For example, immediately after you learn to loop with the GOTO statement, half inch type warns you to "WAIT! STOP! HALT! CEASE! DESIST!" before running, so the saving properties of the Control-C can be explained to keep you from the terror of the infinite loop.

The examples are so clear that not even a computer could complain of ambiguities. The actual keys punched are pictured using the standard key markings of the ASR-33 Teletype. The printed listing for each example explains why you typed this and why the computer typed that.

Besides being an excellent teaching text, the book has the two necessities that make it a handy manual to keep forever, plus several bonuses. The necessities are a set of concise summary boxes at appropriate spots throughout the text gaudily surrounded by polka dots; and a good index that not only tells you where the concept is taught, but the precise location of the summary box. The bonuses are the examples cnosen by the author: a broad set of games, pictures, string techniques and useful business programs, all indexed and ready to run.

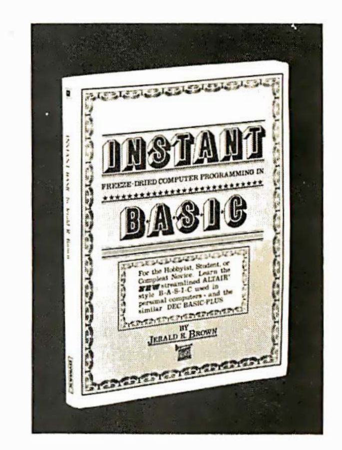
The dialect of the BASIC taught is both a strength and a weakness of the text. Altair 8 K BASIC, revision 3.2 (essentially the same as DEC BASIC Plus), is that ubiquitous version that started so many of us hackers off in BASIC and served us so well. But revision 4.0 is now out, and, especially in its extended version, it far surpasses 3.2 8 K BASIC in flexibility and power. But of course, the further you go from standard BASIC the more machine dependent you become. For the beginner, or those writing for a variety of interpreters, Brown's choice was a wise one.

All said, *Instant Freeze-Dried Computer Programming in BASIC* is the most painless and involving text for that language yet on the market.

Jay P Lucas
3409 Saylor Pl
Alexandria VA 22304 ■

Address Correction

David Clapp, who reviewed Z-80 Programming Manual *by MOSTEK (June 1978 BYTE, page 118) has changed his address to: POB 501, Streetsboro OH 44240.* ■



BYTE's Bits

Portia Isaacson to Edit New Book Series

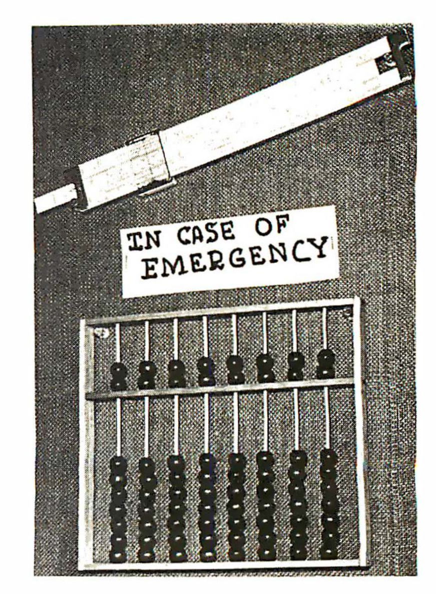
Announcements in BYTE's Bits are usually confined to products and services rather than details of who is doing what in the personal computing industry. We could never hope to find room to print all the people oriented press releases that come our way every month. Because of the contributions she has made to personal computing, however, we are making an exception here to report that Portia Isaacson has now joined book publisher Prentice-Hall as series editor and advisor for the firm's new Personal Computing Book Series.

Dr Isaacson is currently chairperson of the ACM Special Interest Group in Personal Computing, editor of a monthly "Personal Computing" column in *Datamation*, acting president of the Computer Retailers Association, an Electronic Data System fellow, and co-owner of the Micro Store. Named as an honorary fellow of the Association of Computer Programmers and Analysts in 1977, she also chaired the 1977 National Computer Conference. Dr Isaacson has been associated with Textron, Lockheed Electronics, and Xerox Corporation and is a former university professor. She will author the first book in the Personal Computing Series, *The Microcomputer in Business.*■

Heard on a BOMB Card

"If this feedback helps you why is this card not postage paid? I really do not know why I put a stamp on this every month. You really do not want this card back, do you?"

Why does anyone write a letter to the editor? It costs a minimum of $.13 and has no guaranteed or measurable result for the sender. Formalized rating feedback is quite adequately provided by those readers who are opinionated enough to return a filled out BOMB card. If we received as much as 10% of the 135,000 or so cards mailed with the May 1978 BYTE, the analysis would require a nearly full-time person. By providing the filter of requiring a person to back his or her opinion with a stamp, the numbers are kept within manageable limits. . .CH■



At the suggestion of a reader, this emergency equipment now hangs on a certain editor's wall at BYTE. The hexadecimal abacus was created by Blaise Liffick, and the now obsolete scientific and engineering calculator at one time was the primary computer of yours truly. . .CH■

BYTE's Bugs

DeMorgan Gets Half-Bombed

An error appeared in one of the definitions of DeMorgan's two laws in Dan Bunce's "Some Musings On Boolean Algebra" (February 1978 BYTE, page 26, second paragraph). The last sentence of the paragraph should read: "Figure 3a also gives us the other law, $\overline{p} \vee \overline{q} = p \wedge q$." Thanks go to Steve Shade, Lehigh University, Bethlehem PA 18015, for spotting this error.■

Microbot Bug

A minor bug appeared in listing 1 of John Webster's "Robot Simulation on Microcomputers" (April 1978 BYTE, page 136). The assembler code at address 0017 should read: "LXI B, 0A040H" instead of "LXI B, 0A004H." The hex code listing is correct as it stands.■

Correction

The address for Pickles and Trout on page 51 of Dan Fylstra's "The Radio Shack TRS-80: An Owner's Report" (April 1978 BYTE, page 49) should read: Pickles and Trout, POB 1206, Goleta CA 93017, (805) 967-9563. Our apologies to Messrs Pickles and Trout.■

Programming Quickies

Beating North Star—MITS Incompatibility

Alan R Miller
New Mexico Tech
Sorocco NM 87801

If you have a North Star floppy disk and you want to use it to load MITS extended BASIC, there may be a slight problem. The North Star disk operating system requires 2.5 K bytes of memory starting at hexadecimal address 2000. MITS extended BASIC also uses this same area. The solution is simple: load BASIC in the old way (cassette or paper tape), but don't start it up. Next, load the 23 byte automove program in listing 1 at hexadecimal 4000. Use it to relocate BASIC at hexadecimal 4020. Jump to hexadecimal E900 and reload the disk operating system. Finally save the combination automove and BASIC (hexadecimal 4000 to 7FFF for version 4.0; hexadecimal 4000 to 6FFF for earlier versions) on the North Star disk with file name MBASIC.

When you want to load MITS BASIC from disk, type GO MBASIC and the disk will copy BASIC into memory above the disk operating system and jump to the autoload routine. This routine will in turn copy BASIC into its proper location, then jump to it. The disk operating system will, of course, be overlaid by BASIC. When you're through with BASIC, jump to the disk bootstrap to recopy the disk operating system back into memory. With BASIC versions 4.0 and above, type:

DEFUSR=&HE900: X = USR(9) [carriage return].

For earlier versions type:

POKE 65,0: POKE 66,233: X = USR(9) [carriage return].■

```
                    ;HEADER PROGRAM TO MOVE BASIC OVER NORTH STAR DOS
                    ;
                    ;PROGRAMMED BY ALAN R. MILLER
                    ;NEW MEXICO TECH, SOCORRO,  NM  98901,  505-835-5619
                    ;
                    BASIC   EQU     4020H   ;START OF UPPER BLOCK
                    BASEND  EQU     7FFFH   ;END OF UPPER BLOCK
                    BEGIN   EQU     0       ;START OF LOWER BLOCK
                    ;
4000  210000        START:  LXI     H,BEGIN ;DESTINATION ADDRESS
4003  112040                LXI     D,BASIC ;START OF UPPER
4006  01FF7F                LXI     B,BASEND  ;END OF UPPER
4009  1A            NEXT:   LDAX    D       ;GET BYTE FROM UPPER BLOCK
400A  77                    MOV     M,A     ;PUT IN LOWER BLOCK
400B  23                    INX     H       ;INCREMENT POINTERS
400C  13            INX     D
400D  79            MOV     A,C     ;CHECK FOR END
400E  93                    SUB     E       ;SUBTRACT LOWS
400F  78                    MOV     A,B
4010  9A                    SBB     D       ;SUBTRACT HIGHS
4011  D20940                JNC     NEXT    ;CONTINUE IF NOT DONE
4014  C30000                JMP     BEGIN   ;DONE, START PROGRAM
```

Listing 1: Program to move previously relocated MITS BASIC back where it belongs when using a North Star floppy disk. To move the original program, the parameters must be changed. BASIC must be set to hexadecimal 0000, BASEND to 3FFF, and BEGIN to 4020.

Continued from page 11

RSX-11 and DOS-11 variants of the same editor and can testify to the usefulness of the scope support features built into the newer versions. One goes through a rather large amount of hassle with DEC to get the software for RT11 (pricing is never very clear), but the result is fairly worthwhile. If you guys ever get a version of TECO running, I have an ELIZA demo that runs in it, just to show you a bit of what can be done with an editing language.

Glenn C Everhart
211 Great Rd
Maple Shade NJ 08052

IS THERE ANY CP1600 INTEREST?

Have any of your multitude of readers expressed an interest in the General Instrument CP1600 chip and their GIMINI microcomputer? I have been interested in this processor ever since its development and would like to communicate with others on the subject. I was recently talking to one of the people at General Instrument's Hicksville plant and he was telling me about their latest offering, which is a single card 32 K byte (addressed as 16 K words) implementation of this processor including read only memory operating system. This card is to be, in most cases, available as a fully assembled, burned in and tested card for original equipment manufacturer type applications. He also said that it might be possible to discuss a hobbyist type kit, unassembled, perhaps with fewer chips and capabilities and also less expensive. I would like to hear from anyone else who is interested in this powerful 16 bit processor (which uses a very PDP-11 like instruction set) and possibly talk again to General Instrument about interest in the hobbyist kit version.

Brian D McCullough
Site 9, Box 37
RR2
Sherwood Park, Alberta
CANADA T8A 3K2

MULTIPROCESSORS ARE BECOMING EASIER TO DESIGN

The article, "The Intelligent Memory Block" by K Castleman in the March 1978 BYTE, page 186, was an interesting and an enlightening system design concept. However, his premise that the current development of multiprocessing systems is lagging is no longer relevant. This is because of the mechanisms on many new microprocessors.

National's 8060 and Motorola's 6801 and 6809, for example, have the necessary on-the-chip hardware for bus access control. This allows for two or more microprocessors to be interconnected to perform different tasks on a time and memory share basis. Intel's new 16 bit microprocessor, 8086, is interesting because of its software control feature in multiprocessor applications. A special 1 byte prefix attached to any instruction can compel the processor to assert a bus lock signal for the duration of the instruction operation, thereby allowing processors to share resources. By using these new microprocessors the memory block can now be intelligent but with a lot less hardware and timing stringency.

John C Peterson
Jet Propulsion Lab
Pasadena CA 91103

FOR SOME, HIGH PRICE=NO SALE

Thank you very much for your editorial "Don't Ignore the High End . . . .or My Search for Manuscript Editing Paradise" which appeared in the March 1978 BYTE, page 6.

I feel compelled to write to you because my thinking has been parallel to yours on this same topic and for the very same reasons.

I started out with the idea that electric typewriters have been around for many years; there is a market for them and the manufacturers have been able to make profits.

These days we have a lot of very good and very cheap electronics so that it seems reasonable to expect electric typewriters with inbuilt memories and editing capabilities at reasonable prices. The price would also be increased by video displays and magnetic tape storage devices, but I do not expect that it would be anywhere near the $8000 which you mention. The potential market for reasonably priced goodies may well include all those people around the various university campuses who type and retype dissertations, thousands of articles for publication in journals (including BYTE) and term papers. If I could get one with insert and delete capabilities for around $700 I would go out tomorrow morning and get one right away. But that day seems to be rather remote at present.

Philip S Barker
59 Acadia Bay
Winnipeg Manitoba
CANADA R3T 3J1

There is a bit of a difference between an output peripheral (the typewriter) and a complete computer system with soft copy displays, magnetic auxiliary storage and lots of memory.

620/L VARIAN COMPUTER INFORMATION AND PARTS NEEDED

We have a VARIAN 620/L which has been loaned to our computer center by one of our teachers. We are writing to find out if there are any readers of your publication who can help us locate additional plug in boards, either stuffed or unstuffed, for this machine so that we can make more effective use of it. We would appreciate hearing from anyone who may be willing and able to help with *any* aspect of this machine.

Norman Lee, Asst Prof
Electronics-EDP
College of The Albemarle
Elizabeth City NC 27909

DRAMA REQUIRES SPEECH AS WELL AS ACTION

I was delighted to see the article by Gerrard, Ghent, Hemsath and Seawright (June 1978 BYTE, page 153) describing a simple modification to the Processor Technology VDM board which results in a greatly enhanced graphics capability for the small computer user.

It may be of interest to a number of readers that this same modification is also quite useful for displaying and editing the control parameters for the Computalker Model CT-1 Speech Synthesizer. With a vertical resolution of 208 lines, it is possible to display up to three CT-1 parameters simultaneously with 6 bits resolution on each. The horizontal resolution of 64 is sufficient to see more than ½ second of speech data at a time, plenty of display for good editing.

We are currently exploring the possibilities of using such a graphics display in connection with a digitizer pad, which will make it much easier to produce good quality speech output with the Computalker board.

Lloyd Rice, partner
Computalker Consultants
POB 1951
Santa Monica CA 90406
(213) 392-5320

WORD OF A BETTER SORT

As a computer science major interested (when I find the time) in getting into personal computing, I enjoy reading BYTE. In general, the material is worthwhile and educational, but in your April 1978 issue I was greatly disappointed to find one of the worst methods for sorting an array of items that I have ever seen published. Rene Pittet's algorithm, presented in "Programming Quickies," page 148, is a slow variant of the ubiquitous bubble sort. I am writing this letter to inform your readers that there are much better sorting methods around, including some no more difficult to code or to understand.

A well known method (which is about four times as fast as the one Pittet presented) is called straight insertion sort. To understand how it works, observe that at the beginning of each iteration of the FOR-NEXT loop, the first I-1 elements of the array are already in sorted order. The body of the loop merely inserts the Ith element into its correct position in that initial sorted segment. My code segment, which follows, replaces the actual sorting part of Pittet's code.

Insertion sort is probably the method of choice when less than 30 items are being sorted — it is easy to write and to debug and incurs very little overhead. However, it can be shown that the amount of time required to sort N items using this algorithm is proportional to N*N. Thus, if sorting ten items take 100 units of time, 1000 items will take about 10000 units of time! Many algorithms exist which require an amount of time proportional to N times the logarithm of N. I refer the interested reader to a book, which all hobbyists should read anyway, by Kernighan and Plauger: *Software Tools.* They describe the quicksort algorithm, the generally recognized method of choice in a wide variety of applications. Mathematically inclined readers who want to know "everything you ever wanted to know" about sorting (and searching) should refer to *The Art of Computer Programming, Volume 3: Sorting and Searching,* by Donald E Knuth.

```
171 REM      STRAIGHT INSERTION SORT: PUTS THE ELEMENTS
172 REM A(1) THROUGH A(N) INTO ASCENDING ORDER.
173 REM   I: LOOP COUNTER - ELEMENT OF A TO BE
174 REM         INSERTED NEXT
175 REM   J: LOOP COUNTER USED TO SEARCH FOR AN
176 REM         ELEMENT LESS THAN K
177 REM   K: (=A(I)) THE NUMBER ("KEY") BEING INSERTED
180 FOR I = 2 TO N
190   K = A(I)
200   J = I-1
205   REM WHILE A(J) > K
210     IF A(J) <= K THEN 250
220     A(J+1) = A(J)
230     J = J - 1
235   REM UNTIL J = 0
240   IF J > 0 THEN 205
250   A(J+1) = K
260 NEXT I
```

Neal D McBurnett
POB 4173
Brown University
Providence RI 02912

WHY NOT JUST USE THE PHONE?

I was pleased with Mike Wilber's article on CIE standards ("CIE NET: Part 1, The Beginnings" February 1978 BYTE, page 14) and look forward to seeing more in the same vein. However, I was not equally taken with Jeff Steinwedel's article ("Personal Computers in a Communications Network" February 1978 BYTE, page 80) on the

use of RF in a data exchange network. His generalities do no justice to the enormous technical, political and financial complexity of such a system. It is unfortunate that someone who must know quite a bit on this subject would author oversimplifications which could lead less well informed persons to believe that such a system is really a practical option.

Anyone who plans to propose that the FCC allocate 1 MHz of precious VHF or UHF spectrum for a short haul, fixed, unattended, personal radio communication service should be prepared to be laughed out of Washington. First, just where does Mr Steinwedel suggest that this 1 MHz come from: amateurs, government, broadcasters? Don't count on it! The fact is that there is nothing like a 1 MHz block available below 900 MHz. Second, all services are allocated frequencies on the basis of international standards and demonstrated need. How can anyone demonstrate the need for a frequency hungry radio network to link homes around town so we can all play *Star Trek* together? How would he reply when asked, "Why not just use the phone?" Third, Mr Steinwedel totally ignores the high cost of such a system. This is probably due to the fact that amateurs don't have to pay first class technicians to maintain their equipment. Why do you think the cost of mobile telephone is so high? Finally, the suggestion that the FCC would authorize this service to employ totally unsupervised transmitters exhibits unfamiliarity with one of the prime principles of FCC regulation. That is, who is going to pull the plug when the thing gets stuck in transmit mode? Every chapter of the *FCC Rules and Regulations* expounds on this principle at length under the heading of "Operator Requirements." The cases where the FCC has authorized totally unsupervised transmitters are so few as to not be worth noting. In short, why don't you just use the phone?

I don't want to give the impression that I am totally against digital radio communications. It is fine by me if amateurs wish to combine hobbies. I personally would love to help set up an intercity tropo or satellite link for CIE use. However, I would not be so bold as to suggest that it would be cheaper than "Ma Bell."

Anyone who wishes to explore the possibilities of digital exchange and calling by radio should obtain a copy of the *International Telecommunications Union CCIR Study Group 8 Draft Recommendation #493* which proposes some international standards for similar systems. I would also suggest that anyone interested in writing CIE standards should first take a long look at standards accepted by the ITU and other organizations so that international compatibility can be maintained.

Donald R Newcomb
819 Bayou Blvd
Pensacola FL 32503■

College Sports Report

Grinnell Wins Second Midwest Regional Programming Competition

Grinnell College of Grinnell IA barely nosed out DePauw University of Greencastle IN in the Second Midwest Regional Programming Competition held at Taylor University, Upland IN, April 1 1978. The host team, Taylor, finished third and Wabash College of Crawfordsville IN was fourth. Grinnell's 2 person team led by Scott Parker of Champaign IL and sponsored by Prof Mark Grundler defeated DePauw's squad by only three points in the 4 person, 4 hour competition using Taylor University's DEC timesharing system. However Evansville University used their IBM 360 over telephone lines for the competition.

Each team had only one 300 character per second printing terminal on which to write, test and debug their programs. A team of six judges led by chief judge Bruce Gaff of Plycom Industries (Plymouth IN) and Jere Truex (Upland IN) reviewed the solutions written in BASIC and indicated if the solutions were correct or incorrect. The scoring method included the number of problems, the time required to complete the solution, and the number of judged runs submitted.

The four problems posed included writing check amounts in words, screening inaccurate data from an electronic instrument for accuracy, connecting pairs of points in a geometric plane, and retrieving prices from descriptions in a catalog.

Although 14 teams from seven midwestern states were expected, schedule changes and other factors caused some teams to miss the competition. In addition to the four teams already mentioned, others competing were the University of Wisconsin/Platteville, Asbury College of Kentucky, plus Grace College and Rose-Hulman Institute from Indiana.

Next year the Midwest Region will be held at Rose-Hulman or Taylor University. It is hoped that a National BASIC competition between regional champions will be held at a later date. Taylor University had two freshmen on their third place team and other schools had freshmen participating also, so it is anticipated that next year's competition will be even more strongly contested.

Taylor's young team included senior Steve Olsen from Wyckoff NJ, junior Mark Tomlin of West Milton OH, plus freshmen David Woodall of Marengo IL and Stan Rishel of Kalamazoo MI. The alternate members were freshmen Cory Waller of Franklin Lakes NJ and Mark Collins of Indianapolis, who missed the competition because of illness.■

How to Choose a Microprocessor

Lou Frenzel
Heath Company
Benton Harbor MI 49022

All personal and hobby computers are microprocessor based. That is, they use a single processor integrated circuit chip. One of the most important decisions you will ever make in purchasing a personal computer is choosing the type of microprocessor. The semiconductor manufacturers have provided computer designers with a wide range of microprocessing units having varying degrees of power and sophistication. As a result, there are at least a half dozen different processors available in hobby computers. This wide variety of products makes your choice somewhat flexible, or at least it seems that way. In reality, having so many processor styles to choose from, your decision becomes much tougher. If you are a beginner, it may be particularly difficult to make an intelligent choice. The purpose of this article is to provide you with some guidelines in making this important decision. The emphasis is on how to choose the best microprocessor for you when purchasing a personal computer.

What's Available

Below is a list of all of the available microprocessor architectures and their primary manufacturers.

Intel 8080, 8085, 8048, 8086
Motorola 6800
MOS Technology 6502
Zilog Z-80, Z8000
Signetics 2650
RCA 1802
Fairchild F8, 9440
MOSTEK 3870
Intersil 6100
Texas Instruments 9900
National Semiconductor SC/MP, PACE, 8900
DEC LSI-11
Data General microNova
General Instrument 1600

With this wide variety, is it any wonder that it is a difficult choice? Yet with all of these available devices, the choice narrows down rather quickly when several important factors are considered. What makes things even more confusing is the fact that many of the above microprocessors will undergo changes and improvements. Semiconductor manufacturers will also develop and introduce even newer improved microprocessors. The whole microprocessor business is a dynamic one. Changes occur almost daily. The biggest dilemma is not so much the changes themselves but the rapidity with which they occur. Today you may make a decision to use a particular microprocessor only to find that six months later the choice is apparently incorrect because a newer, better, improved device has become available. There is no complete solution to this problem. The rapid changes in this field will continue to occur. For that reason, you must make a choice and stick with it. You must attempt to select a device that has the greatest longevity potential as well as one that meets the criterion for performance in your application. You must not let the rapidly changing technology paralyze your decision making process. It is best to choose among the presently available devices and take your chances with the future. To obtain the most value from your personal computing system, you must select a microprocessor that meets your immediate needs but offers future potential as well.

Selection Criteria

There are many factors that go into the process of selecting a microprocessor. You should consider all of these factors even though some of them affect you only indirectly. You should also be influenced by the factors that ordinarily would interest

only the designer. Below are listed some of the key elements in choosing a microprocessor.

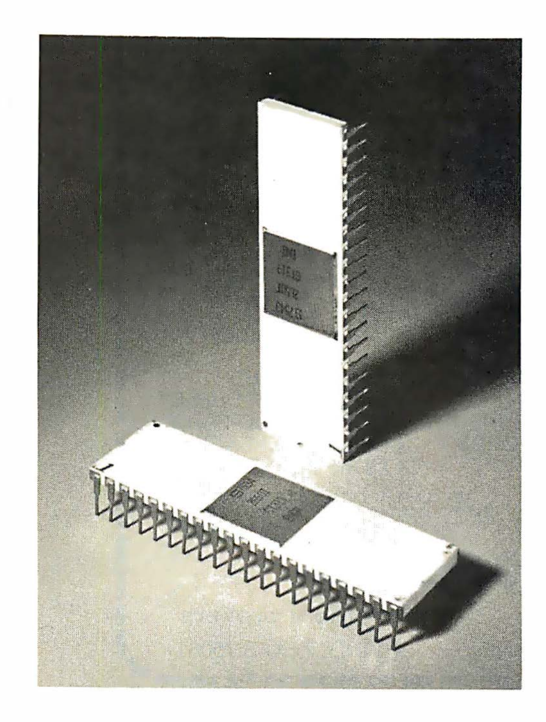
Cost

Cost is always a major consideration in choosing a microprocessor. However, of all the factors involved, this is one that the user should be least concerned about. Cost is primarily the concern of the computer manufacturer. Most microprocessor integrated circuits are in the same price range; and the cost of the microprocessor itself is only a fraction of the overall cost of the computer system. The cost of memory and peripherals is far more than the cost of the processor. Thus for purposes of our discussion here, cost is irrelevant.

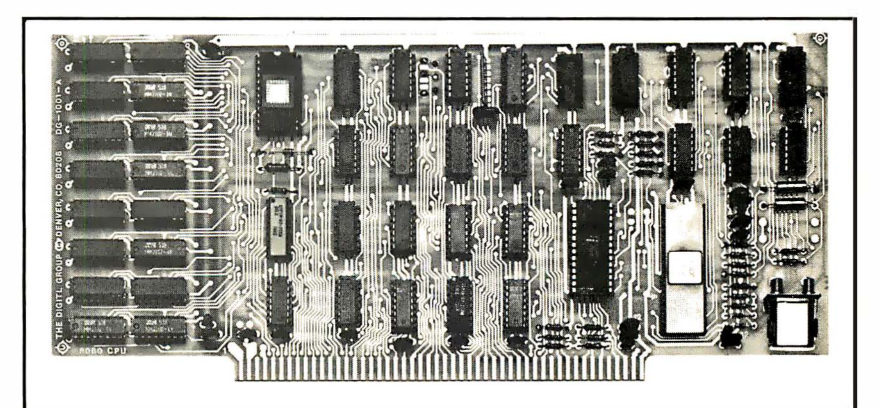
Speed

One of the factors considered in the evaluation or comparison of computers is processing speed. This is the rate at which instructions are executed. While speed is primarily a function of the clock frequency and the upper frequency limit of the microprocessor itself, it is also affected by the memory speed and the architecture of the processor. Most modern microprocessors are not known for their processing speed. After all, most microprocessors are metal oxide semiconductor (MOS) circuits which are inherently slower than bipolar (TTL) circuits. Over the years great improvements have been made in the speed of MOS circuits. The slow "P channel" circuits have been gradually replaced by smaller and faster "N channel" circuits. Continuing developments in the N channel process promise even further improvements in speed. Speeds approaching bipolar levels are achievable. If processing speed is the most important criterion, then bipolar circuits should be selected over MOS microprocessors. Speed is of little or no consideration in choosing a microprocessor-based personal computer. Most MOS microprocessors used in personal computers execute an instruction within several microseconds which is fast enough for most applications.

While processing speeds can vary as much as four to one among MOS microprocessors, the difference is almost unnoticeable. For



From the machine and assembly language programmer's point of view, the Signetics 2650 processor shown here is often considered to be a superior machine. But it has never become popular in the personal computing field, most likely because it entered the 8 bit marketplace later than the major contenders. This photograph was supplied by Signetics.



The Digital Group leaves out no major microprocessor choice. While their emphasis is on the Z-80 processor, they cover all bases with options for 8080, 6800, 6502 and Z-80 processor boards. This photo, supplied by Digital Group, shows a board which features the 8080 processor.

example, most hobbyists use the BASIC language. The speed of the microprocessor will definitely determine the length of time that it takes to execute a program. However, with an interpretive language such as BASIC, an order of magnitude difference in execution speeds is frequently almost unnoticeable to the user. While it may take 200 μs to execute a program on one computer and 20 μs on another, the user is often totally incapable of recognizing the difference.

The real value of speed comes when your application requires it. If your applications involve lengthy, complex mathematical operations or highly complex real time functions, speed may be an important consideration. Otherwise, speed is one factor which you could practically ignore in the selection of a personal computer. Few personal computer manufacturers know how to specify it, let alone mention it.

Computing Power

Computing power is a rather nebulous designation that refers to the power of the instruction set and architecture of the computer. Computing power also effectively involves speed as discussed above. Yet computing power is far more important than raw speed in determining the capabilities of a microprocessor.

It is difficult to provide any specific guidelines for determining whether one microprocessor is more powerful than another. However, as a general guideline there are several factors to look for in determining which microprocessor has the greatest power. These factors are: number of instructions in the instruction set, number of working registers, and number and type of addressing modes. Those microprocessors with the greatest numbers of instructions, registers, and addressing modes are essentially the more powerful microprocessors. They can accomplish more complex operations in less time than other microcomputers with lesser characteristics.

It is the wide variation in architectures which makes the choice of a microprocessor interesting. In some cases, a superior instruction set, more flexible register organization and more addressing modes can offset the superior computing speed of another microprocessor with a simpler architecture. There are never any clear cut answers to the question of which microprocessor is the most powerful since usually the answer lies in a specific application. When a particular application can be defined, the choice of microprocessor can be optimized. However, when choosing a microprocessor-based general purpose computer which must be

useable in a wide range of applications, the speed and computing power consideration becomes fuzzy at best.

Second Sources

Another way to assess the value of a microprocessor is to consider the second sources. Second source refers to a manufacturer other than the original manufacturer, producing the same device. When a semiconductor manufacturer introduces a new microprocessor, he attempts to capture as much of the market as possible with various features and pricing strategies. However, one of the strategies that works best is if competing manufacturers choose to make the same device. These secondary manufacturers will compete with the primary manufacturer. Despite this competition, it is usually the original manufacturer who benefits from this situation. It provides alternate sources. The competition creates pricing advantages. In addition, the reliability of supply is improved. One way to determine the popularity and widespread use of a microprocessor is to determine its second sources. The more second sources that a device has, the more widely it is used and the more competitive is the pricing. Don't overlook this as a way of choosing a microprocessor.

Popularity

It may seem almost ludicrous to include such a general and seemingly meaningless criterion for selecting a microprocessor as popularity. Yet this rather inexact factor is important. Most people tend to want to go along with the crowd. They want to select devices that are well known and widely used by others. For that reason, you cannot overlook the popularity factor. Most people feel that a device that is popular and widely used must have something going for it. This tends to make their own choice easier. In effect, they are relying upon the decisions of many others to back up their own decision. This is why Chevrolet sells more cars than any other US manufacturer. Popularity in computing also has benefits with regard to availability of software.

The choice of a microprocessor is also largely emotional. Even though a device may not have the benefits of software availability, speed and computing power, the device may be highly regarded. This may be because of the reputation of a particular manufacturer or a particular unique feature. Many times the features or benefits are perceived rather than real. A strong sales pitch by a trusted friend or respected source can also easily sway an individual's choice. In

selecting a microprocessor, you are often buying mystique or potential rather than real practical computing capability. The thought of having the newest, best, fastest, most powerful microprocessor is a strong selection inducement. While these factors will no doubt influence you, you should attempt to be more practical, realistic and analytical in the selection of a microprocessor for your own personal computer.

Documentation

Documentation refers to all of the written material available for a particular microprocessor. This includes magazine articles, books, courses, manufacturers' literature and any other printed sources. Good documentation is hard to come by and often it will make the difference between failure and success in getting your system to work. You will get more value from your own investment if you have plenty of written sources to refer to and to help you in applying it. This is particularly true if you are a beginner. The more sources of information you have for the microprocessor, the easier it will be for you to learn to use it. You should always consider this factor before making your final decision.

Upwards Compatibility

Upwards compatibility refers to the future of a given microprocessor. It tends to indicate that a particular microprocessor will eventually be upgraded or replaced by a compatible device. Computer manufacturers found out early that upwards compatibility was an extremely important part of their development and marketing strategy. The upwards compatibility factor is tied to software. Individuals who purchase computers proceed to develop considerable amounts of their own application software. If at a later date they decide to replace that computer, they must take into consideration the status of their applications software. If the replacement computer is upwards compatible with the previous computer, their present software will run on the new computer. Because of the significant amount of time and money invested in software, the desirability of upwards compatibility is extremely important. If an entirely different microprocessor or computer is selected, it may be necessary for the users to completely convert or abandon their present software. This is highly undesirable since it involves throwing away a considerable investment.

When considering a microprocessor, you should examine the concept of upwards compatibility. Will the microprocessor you

select eventually be replaced and upgraded by a compatible improvement? If so, it is probably a good choice. This means that you will obtain valuable usage from your present computer but then ultimately upgrade to a more powerful system at a later date without any loss of software capability. Most of the major microcomputer manufacturers are quickly learning the importance of the upwards compatibility concept.

Software

It seems almost unnecessary to mention the importance of the software factor in choosing a microcomputer. Even a beginner quickly learns that the microcomputer hardware itself is useless without good software. This means not only good systems software that allows you to develop your own applications programs, but also the availability of a wide range of "canned" or predeveloped programs which can be run on the computer. Most computer hobbyists want to write and develop their own programs. But the value of their systems is higher if they can also readily obtain other software that will run on their computers. *All things considered, software and its availability is by far the most important decision making factor in choosing a microprocessor.*

There are two software considerations which you should make. First, how easy is the microprocessor to understand and program? Second, how much software is available for that particular device? In the first case, the simplicity of the instruction set and architecture makes a great difference in learning to use a microcomputer. If the instruction set is straightforward and the architecture textbook-like, the microcomputer will be easy to program and use. Even a beginner will learn to use it quickly and obtain satisfactory results.

In the second case, how much software is available for the microprocessor? If the microprocessor is popular and very widely used, chances are there is a tremendous amount of software available. Programs are listed in magazine articles or are available for sale. Regardless of the source, if software is available for the microprocessor, then the choice is a good one. The lack of available software is a clear indication that the processor is not widely used and that you will have to develop most of the software yourself should you choose it. Software should be your single most important consideration in choosing the microprocessor. All other factors, speed, cost and computing power are practically irrelevant or at least far less important than the software consideration.

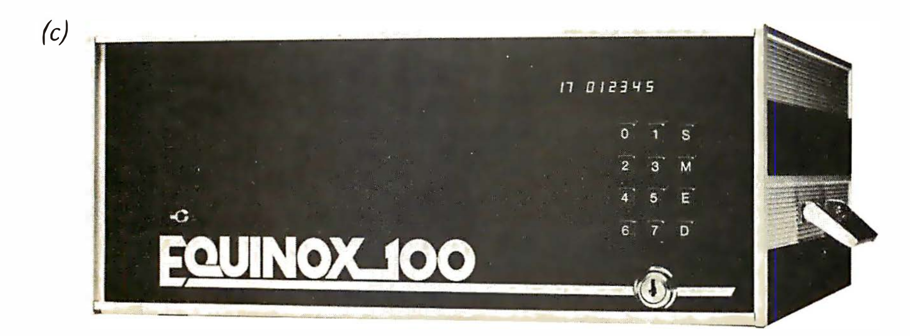
(a)



(b)



(c)



Shown at (a) is the Heathkit H8 computer, which uses the 8080 processor to provide general purpose computing capability. It is typical of a number of units based on the popular 8080, Z-80, 6502 or 6800 processor integrated circuits. Other examples of personal computers include the Cromemco Z-2 (b), and the Equinox 100 (c).

The Big Four

Of all the microprocessors listed earlier, four are clearly the most popular and widely used. It is probably safe to say that these four devices account for more than 90 percent of all microprocessors used in personal computing systems. It is strongly recommended that you choose one of these four devices when selecting your microcomputer.

The microprocessors most widely used in hobby and personal computers are the 8080, the 6800, the 6502 and the Z-80 in that order. You won't go wrong if you choose one of these four microprocessors. A considerable amount of software is available for each and there is evidence to support the concept of upwards compatibility. Let's take a look at each of these devices and analyze its present capabilities and future potential.

8080

The Intel 8080 microprocessor was the first of the second generation 8 bit microprocessors. Because it was first, it readily captured a large portion of the 8 bit processor market. Later second generation microprocessors such as the 6800 had a more difficult time in penetrating the marketplace simply because of the great lead that Intel held. The 8080 was announced in 1973 and even today despite inroads by other 8 bit microprocessors, the 8080 is still "king of the hill."

While the architecture, speed and computing power of the 8080 are not spectacular when compared with other chips, it is nevertheless a useable device. It has proven its worth and value time and time again not only in dedicated industrial control applications but also in stand alone general purpose microcomputers. It is so widely used and well documented that it is by far one of the best choices you can make. In addition, there is more software available for the 8080 than for any other 8 bit microprocessor. While exact data is difficult to obtain, an estimate I have seen claims that over 60 percent of all 8 bit microprocessors in use are 8080s.

Another factor that the 8080 has going for it is that upwards compatible devices are available. Intel's new 8085 microprocessor is an improved 8080. By using the 8085, you can develop a microcomputer with greater capabilities than the 8080. The 8085 uses fewer support chips since the clock and system controller functions normally required for the 8080 are effectively built into the 8085. In addition, the 8085 uses a single power supply eliminating the additional two supplies required by the

8080. An added bonus is that the 8085 operates at a higher speed and has several more instructions.

Another upwards compatible device for the 8080 is the well known Z-80. This device is a newer and more powerful microcomputer with far greater capabilities than the 8080. Nevertheless, the Z-80 was designed to include the 8080 instructions so that software written for the 8080 will also run on the Z-80. The 8080 instruction set is in effect a subset of the Z-80 instruction set. The Z-80 is not only faster but has nearly twice as many instructions making it a far more powerful microprocessor. Like the 8085, the Z-80 requires fewer external support chips and only a single 5 V power supply in contrast to the 8080.

Evidence of the popularity of the 8080 can be demonstrated simply by listing the number of personal computer manufacturers who use the 8080. A probably incomplete list of manufacturers of 8080 systems includes:

- Digital Group
- E&L Instruments
- Equinox
- Heath Co (H8)
- IMSAI (8080)
- MITS (Altair 8800b)
- PolyMorphic
- Processor Technology
- Vector Graphic

There are more 8080 based personal computers than any other type.

Another consideration is the number of second sources available for the chip itself. As indicated earlier, the number of second sources is a clear evidence of the popularity of a particular microprocessor. Semiconductor manufacturers typically will not gear up to second source a device unless there is a large demand and an identifiable market for that device. A list of suppliers of the 8080 is given below.

- Intel (the original 8080 design)
- Advanced Micro Devices
- Texas Instruments
- National Semiconductor
- NEC (Nippon Electric)
- Siemens

Again, there are more second sources for the 8080 than for any other 8 bit microprocessor.

Another factor to consider is the bus design associated with the 8080 based microcomputers. The popular MITS Altair or S-100 bus is used by most of the manufacturers incorporating an 8080. The S-100 bus is in effect an 8080 bus. The signals defined on that bus are peculiar to the 8080. The S-100 bus over the past several

years has become nearly a standard. While not an official standard, it does nevertheless provide the user with a wide choice of options and accessories for his 8080 based microcomputer. However, keep in mind that the Altair bus became a de facto standard by virtue of being the first widely sold design. Many manufacturers jumped on the Altair bus bandwagon when they started because it had a built-in marketing advantage; this helped snowball interest in the Altair bus. While the Altair (S-100) bus is certainly not an optimum choice, it is strong inducement to many individuals simply because so many people are using it and so many accessory products are available. By choosing an 8080 microprocessor you will no doubt at the same time be choosing an S-100 bus. That isn't all bad. Keep in mind, however, that several 8080 designs on the market do not use the S-100 bus. Notably these are the Heathkit and Digital Group designs.

6800

The second most popular and widely used microprocessor is the Motorola 6800. It was announced almost a year after the 8080. Despite its time lag behind the 8080, the 6800 has come from behind to capture a rather large following. While it is still not as widely used as the 8080, it is a clear-cut second place with many followers and supporters.

The architecture of the 6800 is extremely simple. It is a classic, almost textbook-like design. Its instruction set is easy to learn and understand. And at the same time, it incorporates a variety of addressing modes. While it is slightly slower than designs like the 8080 or Z-80, the 6800 makes up the lack of speed in its superior instruction set, architecture and addressing modes.

A wide variety of software has been developed for the 6800. This software is widely available to most 6800 users.

The popularity of the 6800 can be illustrated by the number of hobby and personal computer manufacturers using the 6800. A probably incomplete list of these is given below.

Southwest Technical Products (SwTPC 6800)
Wavemate
Electronic Products Associates
MITS (Altair 680b)
Digital Group
Motorola
MSI
Heath Company

A list of second sources for the 6800 chip is given below.

Motorola
American Micro Systems Inc
Fairchild
Hitachi

Unlike the 8080, the 6800 does not appear at present to offer upwards compatibility. It is possible that a more powerful 6800 will be offered in the future. However, improved versions of the 6800 have been announced by Motorola. They include features such as on-chip clock and memory and higher speed versions. These improved versions will help lengthen the life of the 6800.

All in all, the 6800 is a well established microprocessor. You will certainly not go wrong in choosing this device in your microcomputer.

6502

The MOS Technology 6502 is essentially in third place in the hobby and personal computing field. This device is very similar to the 6800. There are a number of differences in that the 6502 does feature an on-chip clock, only one accumulator, and different indexed addressing modes. It is widely used in hobby and personal computers.

Due to the large number of KIM-1 computers in the field, the 6502 does have an enthusiastic following of users and an independent users' publication.

Some of the personal computers using the 6502 are listed below.

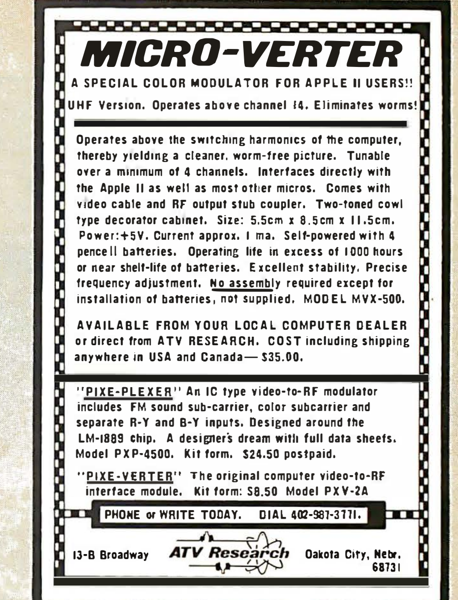
Ohio Scientific Instruments
Apple Computer
MOS Technology (KIM-1)
Commodore PET
Microcomputer Associates JOLT

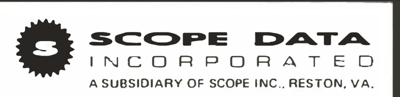
At the present time there are three sources for the 6502. These are MOS Technology, Synertek and Rockwell.

While the 6502 is way down the list in terms of popularity when compared with the 8080 and 6800, it is still a widely used device. Like the 6800, it is simple to learn and use. It is a practical choice for a personal computer.

Z-80

The Z-80 is one of the most popular and certainly the most talked about 8 bit microprocessor of 1976 and 1977. While it was introduced a number of years after the 8080



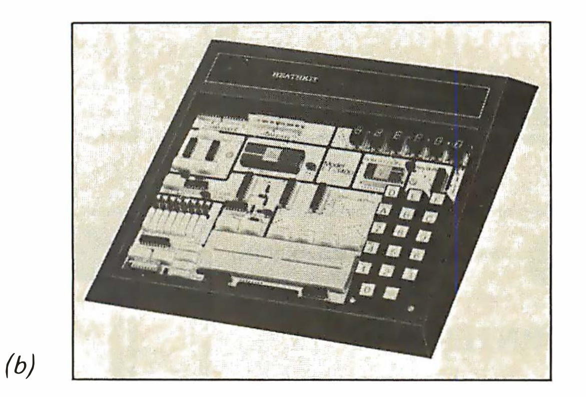




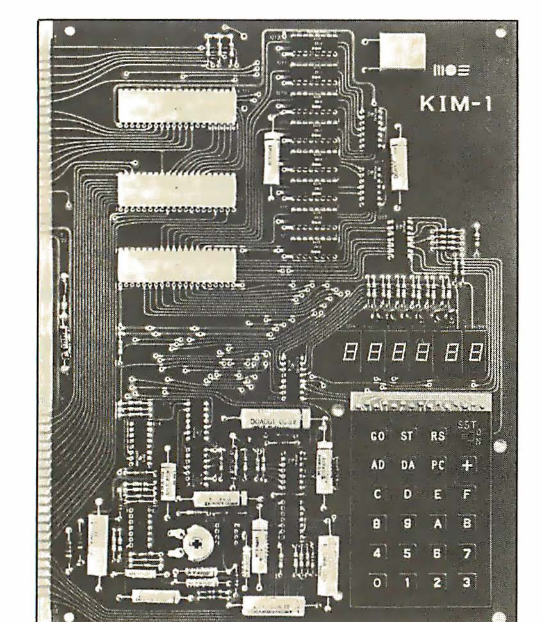


(a)

(d)



(b)



(c)

Several firms manufacture microprocessor trainers like these. The unit at (a) is an E&L Instruments MMD-1 8080 based trainer, shown with a tape recorder for mass storage and documentation. The unit at (b) is the Heathkit ET3400 trainer, based on the 6800 design. The unit at (c) is the MOS Technology KIM-1 single board 6502 computer, probably the most widely sold board in personal computer experimental circles. The unit at (d) is a Motorola 6800 training kit available from the manufacturer. (These photos supplied by the respective manufacturers.) The training computers tend to have limited memory and limited peripheral capability, but excellent documentation designed to train technical people in the operation of a particular computer and in general principles of computer controlled systems.

and 6800, it has managed to capture a significant portion of the microprocessor market. It has also been widely accepted in hobby and personal computing. Because it is essentially an improved and more powerful 8080, the Z-80 can be considered a part of the 8080 movement. Nevertheless, it deserves some attention on its own.

Some of the personal computers using the Z-80 are listed below.

Technical Design Labs
Cromemco
Digital Group
Radio Shack

The Z-80 also has two primary suppliers. These are Zilog and Mostek.

Since the Z-80 will run most 8080 software, it is an excellent choice with respect to software. Besides the upwards compatibility and software factors, the Z-80 is also far more powerful. It runs at a higher speed, has a larger instruction set and more sophisticated addressing modes. The Z-80 is perhaps the best 8 bit microprocessor currently on the market.

Despite these advantages, the several Z-80 based processor boards developed as replacements for S-100 based microcomputers have not been all that popular. It is difficult for the owner of an 8080 based Altair bus microcomputer to justify a three or four hundred dollar expense simply to replace an 8080 processor with a Z-80. While you still maintain software compatibility, the Z-80 provides the additional benefits of greater computing power and speed. However, most hobbyists do not require the greater power and computing speed. The capabilities of the less powerful 8080 are more than adequate.

Choosing a microprocessor for a microcomputer design is an agonizing process. Yet once all of the factors are considered, the choice narrows down rather quickly. For a general purpose microcomputer, most designers circa 1975 to 1977 quickly identified the four choices given above. Choosing among them then becomes somewhat subjective. I was personally involved in making

a decision for the microprocessor of the H8 Heathkit computer. When that choice was made in early 1975, the Z-80 was not available. The 6502 was a fairly new device and no second source was available. This narrowed the choice rather quickly to the 8080 and 6800. At that time the 6800 had not penetrated the 8 bit market as much as it has now. As a result, not as much software and documentation support were available. Because of this, the 8080 became the most obvious choice in our planning. Today, even with the greater penetration of the 6800 and the announcement of the 6502 and the Z-80, the choice of the 8080 for the Heathkit H8 was still a good one. The 8080 still has sufficient computing power for nearly any hobby and personal computing application. But today with more choices available, the 6800, Z-80 and 6502 are certainly viable alternatives. At some point in the decision making process, technical capabilities, specifications and other factors become meaningless and the choice is made strictly on subjective or emotional grounds.

What About the Others?

What about all those other microprocessors which are available to the hobby and personal computing user? Why shouldn't a hobbyist consider these devices as well? The answer is a difficult one. First the other microprocessors are certainly capable of producing the same or even improved performance over the most popular devices in use. However, since they have not been widely adopted by microcomputer manufacturers, most of them are simply not available.

2650

The Signetics 2650 is a good example. This device was announced well after the 8080 and 6800. However, it is a superior design in many ways. The 2650 is in effect more like a minicomputer than a microprocessor. It is extremely powerful in that it has a superior architecture and powerful instruction set. It also operates at a high rate of speed. Yet this device never really caught on. Today there are no widely used hobby and personal computers available using this device. As a result, there is limited software available for it. For the homebrew experimenter this device may be an excellent choice provided he is willing to develop his own hardware and support software.

SC/MP

The National SC/MP is another very interesting 8 bit microprocessor. It is perhaps one of the simplest and lowest cost







devices available. Because it is so simple it does not offer the computing power of the other devices. Nevertheless, it is extremely easy to learn and use.

The main reason why the SC/MP has not been widely used is that again no hobby and personal computer manufacturer has selected it for its processor. National Semiconductor does provide several development kits that have found some interest in hobby and personal computing fields. In addition, National has developed a BASIC-like language called NIBL that was developed with the hobbyist in mind. For the homebrew enthusiast, the SC/MP is a good choice.

1802

The RCA 1802 is another interesting 8 bit microprocessor. This is a CMOS device which has extremely low power dissipation. Its low power dissipation has led to incorporation of the 1802 design into one well known experimenter's project, the next series of AMSAT radio amateur satellites. Again, no hobby and personal computer manufacturer has selected this as the primary processor of a general purpose computer. The architecture and instruction set of the 1802 is peculiar and thus more difficult to use than other devices. Little or no software is available. Nevertheless, the 1802 is relatively easy to use and the homebrew hobbyist may find it a desirable choice. RCA makes several development kits that serve as a good starting point, one of which is intended as a low cost hobby computer.

F8/3870

The F8/3870 microprocessor is another widely used 8 bit microprocessor. The F8 is effectively a two chip microprocessor featuring a ROM on one chip. The 3870 is MOSTEK's version of the Fairchild F8 in a single chip form. Neither of these devices has caught on for hobby and personal computer use. Only one hobby and personal computer manufacturer ever announced an F8 based machine and the company which manufactured it appears to be no longer in business. Both the F8 and the 3870 microprocessors were not designed for general purpose computer application. Instead, they were designed to be hardwired digital logic replacements. These are the microprocessors that were designed to be buried inside of equipment as controllers. As a result they make very poor choices as general purpose digital computers.

The same is true of the new Intel 8048/8748. Like the F8 and 3870, the 8048 incorporates all circuitry on one chip. This includes the processor, clock, both pro-

CANADIANS!

Introducing our kit-by-the-month plan available for only $500.00 down and $150.00 per month.

(Write for more information)

IMSAI 8080 KIT: $897.50
ASSM: $1245.20

Canadian Duty and Federal Tax Included

Hobby systems from $999.00 (Kit).
Business/engineering systems from $11,900.00.
(Assembled and Installed*).
Educational discounts available. We will develop custom application packages. Contact us for further information. Send $1.50 for catalogue.

VISA • CHARGEX ACCEPTED

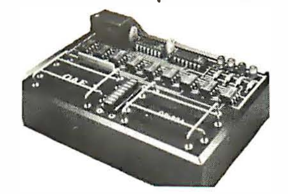


Rotundra Cybernetics
Box 1448, Calgary, Alta. T2P 2H9
Phone (403) 283-8076

(Installation outside Western Canada extra).

Circle 309 on inquiry card.

SAVE $10.00



LAST CHANCE to get the popular OP-80A at the old $74.50 price. Due to increasing costs, there will be a modest price increase (our first) in the OP-80A. Effective July 31 the price will be $84.50 Kit – $99.95 A & T.

Oliver Advanced Engineering, Inc.
676 W. Wilson Avenue
Glendale, Calif. 91203

Circle 292 on inquiry card.

ATTENTION MOTOROLA MEK6800D2 USERS

4 Slot Card Rack
Designed Speicifically for the MEK, MMS68104 MEMORY BOARD, EXORciser, and Micromodule Boards.

Kit $64.95
Assembled $79.95

Check, Money Order, VISA or MC add $2.00 shipping, PA. residents add 6% sales tax.

DEALER INQUIRY WELCOME

PENTEC, INC.
P.O. Box 148, Whitehall, PA. 18052

Circle 299 on inquiry card.

DIABLO TERMINALS!

LIMITED OFFER
HYTYPE I TERMINAL
$1595.00

30 character per second
Daisy wheel printer
RS-232 serial interface



Also:

HyType II
NEC Spinwriter
Qume
Sanders 12/7
Centronics
Univac

Complete line of microcomputer products

MICRO MART
MICROCOMPUTERS, PERIPHERALS AND SOFTWARE
1015 Navarro San Antonio, TX 78205 512/222-1427

Circle 231 on inquiry card.

DAJEN/TELETEK



Dajen Electronics has merged with Teletek to provide greater customer service. We continue to offer the System Central Interface, and the Universal Cassette Recorder Interface. Call or write Ann Roberts for order and information.



Teletek Enterprises, Inc.

11505 B Douglas Road
Rancho Cordova, Ca 95670
916-351-0535

Circle 371 on inquiry card.

USR-310 ORIGINATE ACOUSTIC COUPLER





Operates With Any Standard Telephone

$139

Also Available:

	Direct[1] Connect Style	Telco[2] DAA Style
USR-330 Originate/Auto Answer Modem	$324	$185
USR-320 Auto Answer Only Modem	$299	$160

(1 F.C.C. Certified Package. Connection to phone lines via standard extension phone jack.)
(2 Connection to phone lines via CBS-1001F DAA which can be leased from phone company for approx. $5.00/mo. plus installation fee)

INTERFACES:
- USR-310 — RS232C only
- USR 320 and USR-330 — RS232C and 20mA (Specify with order. If both interfaces are required, add $10 to unit price.)

ALL UNITS FEATURE:
- 0-300 Baud Data Rate
- Stand Alone Unit
- Half/Full Duplex
- 90 Day Warranty
- Fully Assembled and Tested
- Optional Annual Maintenance Coverage

Prices include shipping and handling in continental U.S. Illinois Residents add 5% sales tax.

U.S. ROBOTICS, INC.
Box 5502 / Chicago, Illinois 60680 / (312) 528-9045

Circle 386 on inquiry card.

Engineers Hardware/Software

Touchstone

Our clients are stepping up their engineering effort!

Growth positions in the 15-40K range are available with manufacturers of sophisticated systems. Diverse areas include *Graphic Arts, Text Handling Systems, Micro-Based Controllers, Manufacturing Systems, and Communications.*

HARDWARE - Design capability in TTL and CMOS Devices, Peripherals, and CPU.

SOFTWARE - Real Time Operating Systems, Compilers, and Data Base Design - DOS.

Call us at 603-888-5500 (collect) or send us your resume - in confidence, of course.

Touchstone Associates Inc.
Engineering/EDP Mgt Consultants
104 D.W. Hwy., Nashua, N.H. 03060

Circle 376 on inquiry card.

DISKETTES

VERBATIM for Your DRIVE

MINI Soft Sector / 10 Sector / 16 Sector $3.90 Ea. in boxes of 10
STANDARD Soft or Hard Sector $4.10 Ea. in boxes of 10
CP/M 1.4 for Northstar Disk & Horizon $145
PLASTIC BOX for Standard 10 Diskettes $3
HAZELTINE CRT 1500 with cable $1000
Complete 1•2•3 Computer System: Hazeltine 1500, Horizon-2, Centronic 779 $5145

Visa, Master Charge, Cash, C.O.D.

MANCHESTER EQUIPMENT CO., Inc.
30 Midland Ave. • Hicksville, N.Y. 11801
Call Collect: (516) 433-0613

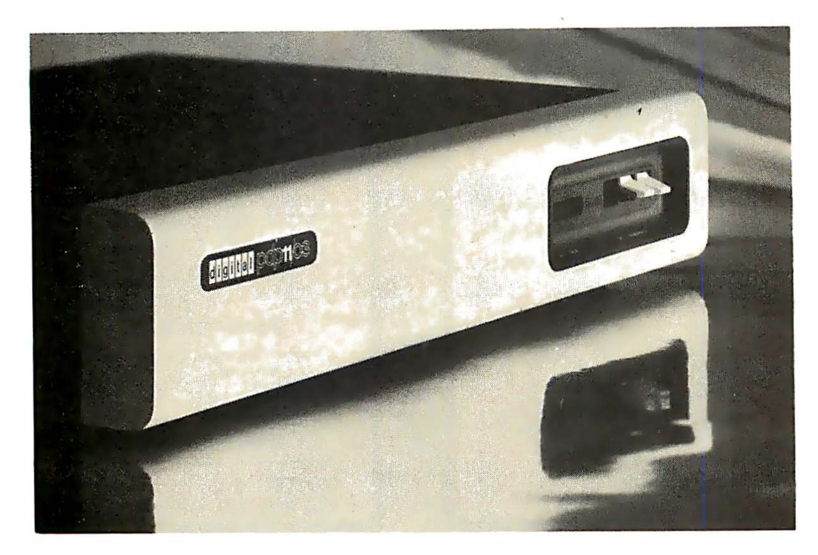
Circle 217 on inquiry card.

BIT BASEMENT BARGAINS

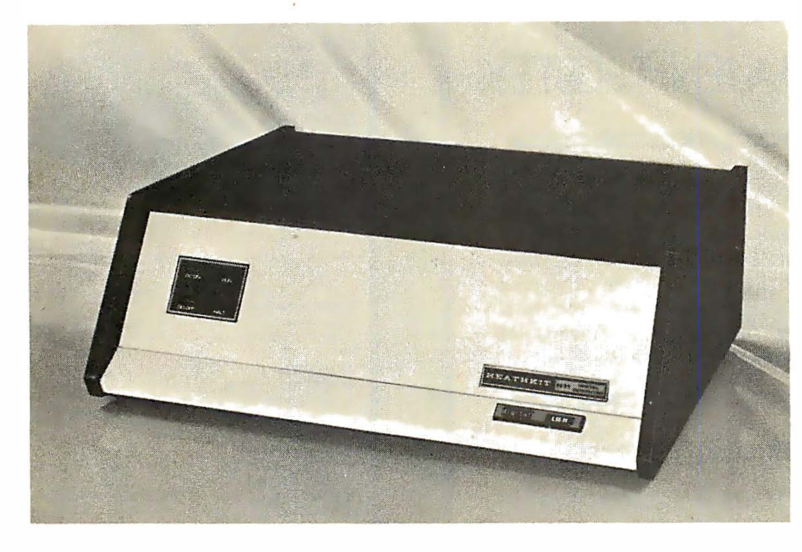
SOROC IQ120 [assbled] . . . $869.95
LEAR ADM-3A [assbled] . . . $859.95
LEAR ADM-1A [assbled] . . $1199.95
16K RAM BOARD [assbled] . $495.00
250nS 180 day warranty
CENTRONICS 779 . . . . . . $1139.95
MICROPOLIS 1042 Mod I . . $779.00

BIT BASEMENT
P.O. Box 1719
Santa Monica, CA 90406
(213) 322-9070
all items shipped FOB factory

Circle 31 on inquiry card.



(a)



(b)

Digital Equipment Corporation, the largest minicomputer company, introduced the LSI-11 microprocessor based single board computer to extend its minicomputer line downward into the microcomputer world. This PDP-11/03 system (a) is the DEC finished package based on the LSI-11. The Heath Company offers a version of the LSI-11 (b) which is called the H11, which is available at lower cost in partial kit form along with extensive documentation aimed at the personal computer kit builder and experimenter. These photos are supplied by Digital Equipment Corporation and Heathkit, respectively.

grammable and read only memory, as well as input and output interfaces. The 8048 was designed as a hardwired logic replacement and not for general purpose digital computer application.

What About 12 and 16 Bit Microprocessors?

Without question the trend in microprocessor development is toward larger, more sophisticated designs. While most microprocessor activity is centered around 8 bit devices, there is clear evidence that single chip 16 bit microprocessors will eventually replace the 8 bit units. As semiconductor technology improves, it will be just as easy to manufacture a 16 bit microprocessor as it is an 8 bit device. When that time comes, the price differential will be minimal. As a result, most purchasers of new equipment will go to the more powerful 16 bit device over the 8 bit device, even though the computing power available is overkill for the application.

There are a number of 16 bit microcomputers and one 12 bit device now on the market. In terms of overall microprocessor usage, their popularity is small. But it is growing rapidly as more devices are developed. As these devices are incorporated in designs, the demand will go up and prices will decline.

Some of the manufacturers making a 16 bit microprocessor are given below.

National Semiconductor PACE, 8900
General Instrument 1600
Data General microNOVA
Digital Equipment Corp LSI-11
Texas Instruments 9900
Fairchild 9440

At present there are few hobby and personal computers based on 16 bit microprocessors. Notably those that are available are the Heathkit H11 which is based on the popular DEC LSI-11 and the Technico 9900, based on the TMS-9900 part from Texas Instruments.

The reason why 16 bit microprocessors haven't caught on in personal computing is that they have not been widely adopted elsewhere. The price is significantly higher than 8 bit devices and little or no software is available. 16 bit microprocessors are far more powerful and can process data much faster than an 8 bit microprocessor. However, for most personal computing applications such power is not necessary.

At this time, the most widely used 16 bit microcomputer is the DEC LSI-11. This particular computer has a wide following among hobbyists because of the great DEC software base. It is an ideal choice for the advanced user.

None of the other available 16 bit microprocessors has yet caught on. The first 16 bit microprocessor available was National Semiconductor's PACE. Despite its early lead, PACE never became popular.

The newer Texas Instruments 9900 16 bit microprocessor shows promise of becoming one of the more popular 16 bit microprocessors. This device may eventually become the 8080 of the 16 bit microprocessors. This device is gaining acceptance in many areas. It is a powerful, general purpose

device. In addition, much of the software available for Texas Instruments minicomputer line is compatible and could possibly be converted in the future for use on this device. Finally, Texas Instruments is one of the largest and most aggressive semiconductor manufacturers. They have the manufacturing and marketing power to support and promote this device. Watch for it in future designs.

The Micro NOVA is another very powerful 16 bit microprocessor. It can effectively run all of the software available for the popular Data General NOVA line of minicomputers. However, this device like some of the others has not caught on. It is an expensive device and not widely available. While the architecture is straightforward and easy to learn and the Data General software base is tremendous, it is doubtful that Data General will promote this device for the personal computing market or make such software available at competitive prices. (However, Data General is promoting the Micro-NOVA through selected retail stores and electronics distributions. Fairchild's 9440 MPU uses the Data General architecture and will run the software. Although it is expensive, someone may eventually use the 9440 in a personal computer.

The Intersil 6100 is a 12 bit CMOS microprocessor. Its claim to fame is that it has the architecture and instruction set of the famous DEC PDP-8/E minicomputer. It will also run software written for that machine. This gives the 6100 an excellent software base. But despite the software advantage the 6100 hasn't caught on in personal computing. One reason is the high price associated with 6100 based computers. These include Intersil's own Intercept series and a machine made by PCM. For the prices of these machines, a user can buy a used but real DEC PDP-8. In any case, the 6100 is a good chip with much potential.



Another 16 bit minicomputer architecture available in microcomputer form is the Data General Corporation's MicroNOVA shown here in a picture supplied by Data General. In the foreground is the processor chip standing alone; in back of the integrated circuit is a printed circuit board version of the computer intended for use in dedicated applications. In the background can be seen the MicroNOVA fully integrated minicomputer system. These products are available at several retail computer stores and at several electronics distributors.

Summary and Conclusion

The message in this article is relatively clear. If you are choosing a microcomputer for hobby and personal computer applications, your best choice lies in the 8080, Z-80, 6800 or 6502 based machines. This is the mainstream of personal computing. The 8080/Z-80 combination probably has the edge over all of these.The biggest question is who is going to make *the* 16 bit microprocessor. Will it be the new Intel 8086? or will Zilog's Z8000 win? We will have to wait and see.

Finally, the message here is that "a processor alone does not a computer system make." When it comes right down to it, the type of processor is almost irrelevant to the user who is programming in BASIC or PASCAL or some other high level language. Overall, it is the software that gets the job done. If you base your choice of a personal computer system on the availability of good system and application software, you will not go wrong, whatever low level machine architecture is used.■

Continued from page 46

The integrated circuit manufacturer can sell parts that would otherwise have to be thrown away, and the designer can buy state of the art parts for prices far below those of the equivalent 16 K part.

The design task breaks down into the following steps:

1. Select the memory chip. For reasons stated earlier, the MK4115 (or equivalent) is the clear choice.
2. Decide how to handle refresh.
3. Analyze the timing requirements for the memory and the processor.
4. Merge these two timing diagrams so that they work together.
5. Design the circuitry.
6. Lay out the circuit board.

Refreshing Strategy

When should you refresh? There are two types of refresh used in a dynamic memory system. *Burst* refresh suspends all other memory activity and quickly refreshes all the required locations at the top memory speed. This burst occurs once every refresh interval (generally every 2 ms).

A preferable approach in a microprocessor system is to use a *distributed refresh* approach, in which refresh cycles are interspersed with processor access cycles. In this manner the refreshing action is evenly spread over the 2 ms refresh interval.

Let's examine some refresh alternatives:

1. Use a 2 ms timer to interrupt the processor and tell it that the memory requires refresh. The processor interrupt routine then counts out the proper memory addresses and returns to normal processing.
2. Use a timer with an interval of 2 ms divided by the number of required refresh cycles, and perform item 1 on a distributed basis.
3. Interleave the refresh operation with normal processor timing: For example, notice (as the Z-80 designers did) that the processor address lines serve no useful purpose on the tail end of an instruction fetch cycle. During this time the processor must decode the instruction fetched from memory in anticipation of executing it. Why not put the refresh cycle (which needs the address lines) into this time slot?

Items 1 and 2 above require processor overhead (processing time) since the interrupt system is used to provide programmed refresh. Of the two, the distributed approach is preferable because it produces less of a timing discontinuity in the background pro-

gram execution while the interrupt is being serviced. Item 3 is best in all respects, since no direct processor intervention is required to perform refresh. This is the so-called "transparent" or "invisible" refresh. This approach has already been implemented in some small system designs. It does, however, have some drawbacks in Altair (S-100) bus products. In examining the details of this approach, we'll describe an even better method of achieving "Altair (S-100) refresh." This discussion assumes an 8080 or equivalent processor.

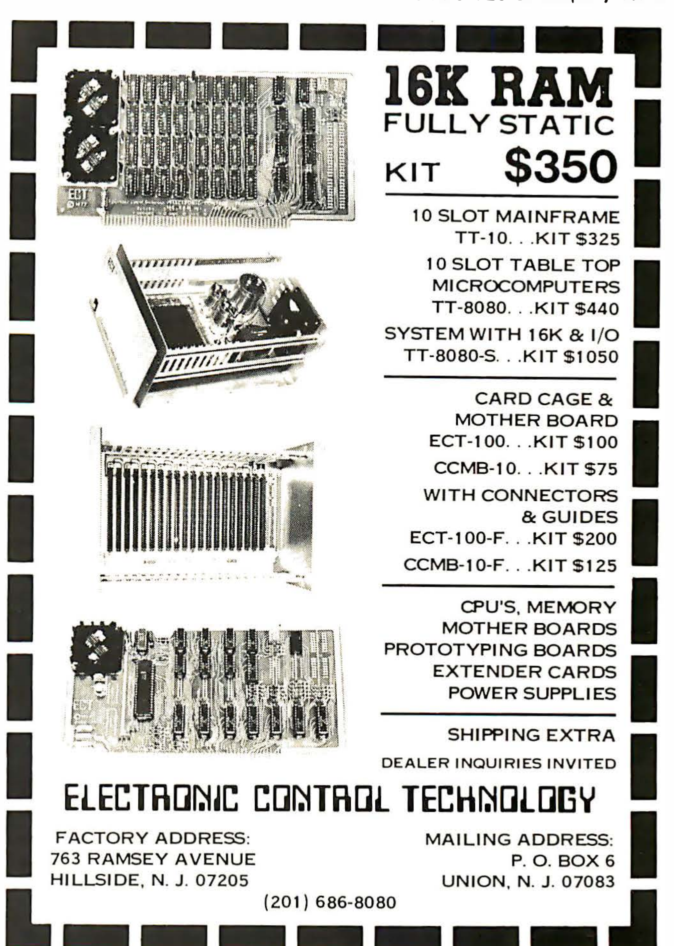
Catching the Bus

The only time the processor can guarantee that the address bus is not needed is the second half of an instruction fetch cycle. This point in time is signified by the processor control signal called M1, which means "memory cycle one" of any instruction. Every instruction execution starts with an M1 memory cycle, in which the instruction is brought into the processor from memory. Depending on the instruction, further memory cycles might be required to finish execution of the instruction. During these subsequent cycles, the M1 signal is inactive. For example, the 8080 STA (store A) instruction operates as follows:

1. M1: instruction word fetched from memory.
2. M2: first half of the storing location read from memory.
3. M3: second half of the storing location read from memory.
4. M4: accumulator contents written into memory location specified by data brought in by steps 2 and 3.

The STA instruction is a 3 byte instruction, and M2 and M3 are needed to read in the additional two bytes of the instruction. M4 does the actual execution of the instruction, storing the accumulator. In this example, the M1 control signal is active only for step 1. The actual M1 cycle is divided into five processor cycles, called time states or "T-states." By the end of T3, the processor has received the first byte of the instruction and now requires two more time states, T4 and T5, to figure out what to do. This is the logical time to force a memory refresh (to be exact, T4 and T5 of M1).

This is all very nice, but what happens when the processor is halted? During HALT, the signal needed to locate the point in time for refresh, M1, is not there. In fact, *most of the processor signals are not there*. This is also true for processor RESET, wait states, and direct memory access cycles. This means



that the design must do something special for these cases.

What is really needed is an approach *independent of processor control signals for refresh.* The only signals on the Altair (S-100) bus that are present under all circumstances (except power off) are the processor clock signals ϕ1 and ϕ2.

Plan Ahead — Backwards

Here's the plan: the memory design should contain a self-contained refresh system that uses only ϕ2 for its operation. The control is arranged so that the memory is normally refreshing, and it is the *exception* cycle that diverts it away from refresh to perform a processor access. This emphasis is "backwards" from most systems, which treat the refresh operation as the exceptional case. Now the card merrily refreshes itself until called on by the processor. If the processor "goes away," for example, in a prolonged wait state (a method frequently used to implement single-step and other front panel operations), the refresh continues.

When the processor needs to access the memory card, it must do it on a synchronous basis. This means that the processor timing on a memory access into the dynamic memory card is designed to not jeopardize a refresh cycle in progress (it is synchronized with the refresh timing). Imagine the processor crashing in on a refresh cycle, and 64 data locations in the memory not being properly refreshed and going to indeterminate states. This is the kind of "soft error" that occurs only when you demonstrate the system ("It worked *perfectly* on the bench. . ."), and promptly goes away when you try to fix it.

Programmable Memory Timing

Let's take a detailed look at the dynamic memory integrated circuit itself, and at exactly what signals are required to make it work. The integrated circuit described could be any of the various 16 K parts of the MOSTEK MK4116 type; or, with one small exception, any of the 4 K parts of the MK4027 type.

Since 16 K is equal to 2^{14}, the part requires 14 address lines to uniquely select any of its cells. Allowing one line for DATA IN and another for DATA OUT, this adds up to all of the pins of the 16 pin package. That's fine if the chip doesn't require power supplies or read and write control, but unfortunately, it does. This dilemma is solved by using a multiplexed address approach. Only *seven* pins are used for address inputs, and the address is loaded in two parts. One

of the big benefits of this approach is that, when the technology jumped from 4 K to 16 K, an additional two address lines could be had with only one additional pin. On the 4 K parts, this "unused" pin is a Chip Select input, which is used to select only one bank of parts that share the same output bus. As we'll see, the 16 K part does the chip select function without a chip select pin.

Two control pins called RAS and CAS strobe the two 7 bit parts of an address into the memory part. These signals stand for *Row Address Strobe* and *Column Address Strobe*. They are active low signals, which means that they are normally at a high logic level, and are "strobed" by going into the low state momentarily.

The sequence of events necessary for a memory cycle is as follows (see figure 3):

1. Set up the low order 7 bit address on the address lines. This requires setting the address multiplexer to state 2 (for example).
2. Wait a suitable time for the address lines to settle. There will be a certain delay through the multiplexer, as well as some line settling time.
3. Drop the row address strobe (RAS) to the low state. This latches the low address into the part. Both RAS and the column address strobe (CAS) start out high.
4. Wait the "row address hold time," which specifies for how long after RAS drops the address lines must not change. This requirement is due to the setup time of the on-chip latches.
5. Set up the high order 7 bit address on the address lines. This requires selecting multiplexer state 3 (for example).
6. Let the lines settle.
7. Drop CAS to the low state. This latches the high address into the part. Don't remove the addresses until after the "column address hold time."

When the logic level of the column address strobe drops, the output lines go from a high impedance state to a valid data state after the interval called "CAC" for Column ACess time. This is one way of specifying the access time of the memory part.

These seven steps are the same for either a memory read or write cycle, the only difference being the treatment of the RW pin which controls the choice of Read or Write operation. If this pin is held high throughout the cycle, a read operation is performed. To do a write, the RW pin is pulled low sometime after RAS. Exactly *when* it is pulled low determines whether the outputs become valid for the old data in the selected cell,

or whether they stay high impedance throughout the write operation.

The chief difference between the 4 K and 16 K part timing is in how the data outputs are treated when the column address strobe becomes inactive (high). In the 4 K part, the data outputs remain valid until the Column Address Strobe again makes a negative transition. In the 16 K part, they enter the high impedance state when the column address strobe goes high, effectively disconnecting the data output from the external bus in a system.

Maintaining Control

There are several ways to control these strobe lines during refresh. The simplest way is to perform a full memory read cycle (row, then column address strobes) and not turn on the data input bus drivers; this does the refresh without affecting the external data bus. The problem with this method is that it is not the lowest power approach. Remember that for refresh only the row addresses (the least significant half of the address lines) are needed. The dynamic memory designers have provided for a mechanism called "RAS-only refresh" in the spec sheets, which consumes less power than a full row and column address cycle. In this method, the refresh counter address is applied to the address lines, and the row address strobe is made active (low voltage level). No other address bits or strobes are needed for this special refresh cycle.

The chip select function in the 16 K memory is performed in effect by row and column address strobe timing (remember that the chip select pin was sacrificed for an additional address pin in the transition from 4 K to 16 K). The method is quite simple: only those devices that receive both row *and* column address strobes in a memory cycle will activate their outputs; otherwise they will be in a high impedance condition. This means that it is possible to select one bank of programmable memories out of many whose outputs are tied together by (a) feeding a continuous row address strobe signal to all parts, and selectively feeding a column address strobe to only the selected bank, (b) the opposite (feeding a continuous column address strobe and selecting a bank with row address strobe), or (c) both (selecting a bank with choice of column and row address). The manufacturers' literature frequently refers to this as "decoded RAS" or "decoded CAS."

There is a slight power advantage to feeding the column address strobe to all devices and decoding the row address strobe to do bank selecting. However, a refresh cycle

using the row address strobe only uses less power than a "RAS-CAS" refresh cycle using both strobes, as noted above. It turns out for logic simplicity (a real consideration in view of the small amount of Altair (S-100) bus card space available) that the decoded column address strobe method of selection is the optimum choice. It also happens to fit beautifully into the 8080 system timing.

It is now apparent that the programmable memory address pins must be fed from three different sources: for a processor access, the low address half and high address half constitute two of the sources; and for refresh, the refresh counter address constitutes the third. To select these three groups of address lines, a TTL multiplexer (74153) may be used. This is a dual one-of-four selector that accepts four inputs and feeds a common output. The input which is selected depends on a 2 bit code (called the select bits) input to the multiplexer. These signals are labeled MUX1 and MUX2 (see figure 4). For the 8 K part, which requires 14 address lines, the multiplexer has to be seven bits "wide" so that the switching is done seven bits at a time. This means that three and one half 74153 integrated circuits are required.

Processor Timing

Turning our attention now to the 8080 system control signals, the dynamic memory timing must be "dovetailed" into the 8080 system timing. Figure 4 shows the timing for an 8080 fetch cycle.

Lines 1 to 4 are control lines common to any 8080 system: the two clock signal inputs $\phi 1$ and $\phi 2$, the address bus (actually

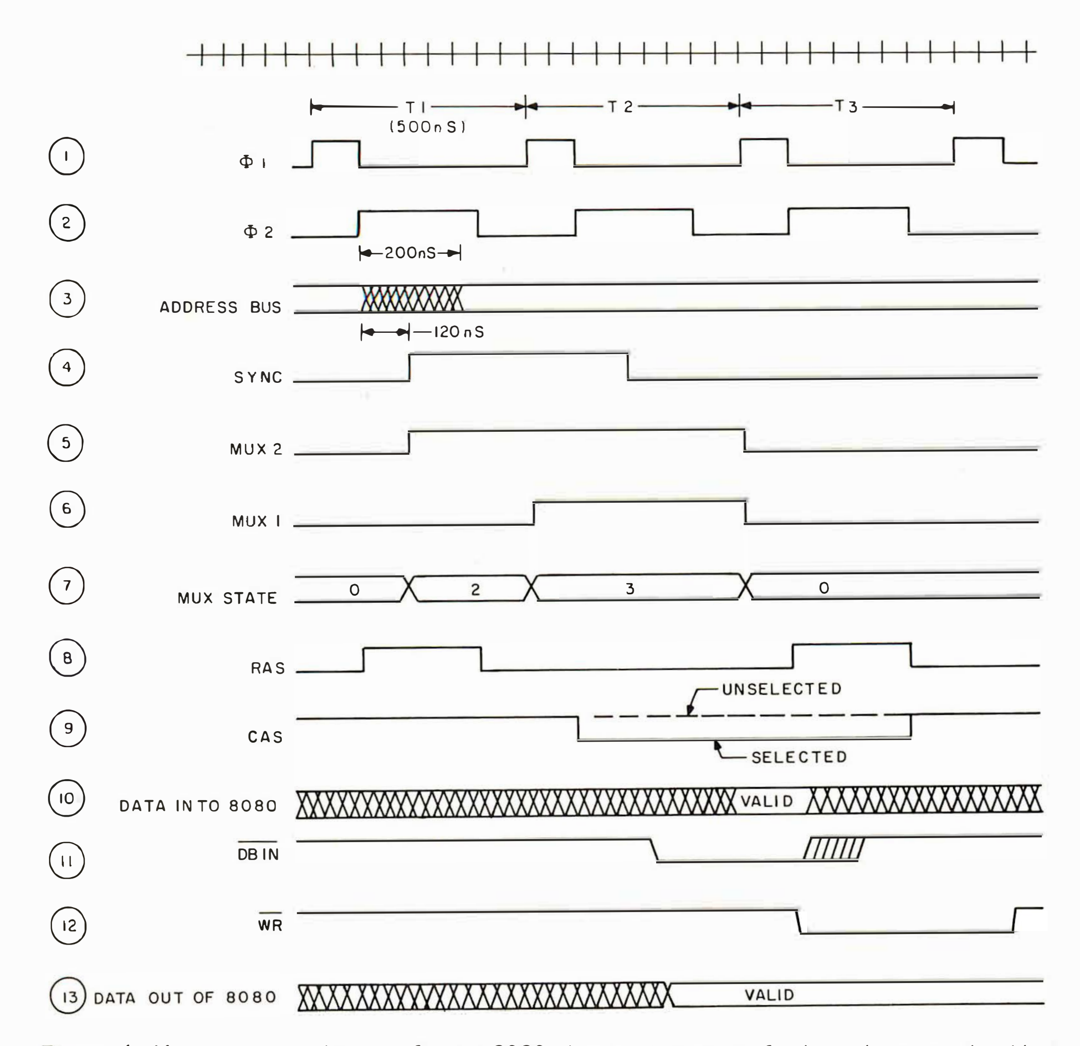


Figure 4: Master timing diagram for an 8080 dynamic memory fetch cycle using the Altair (S-100) bus. Lines 1 thru 4 show the control lines common to all 8080 systems: the two clock signal inputs ($\phi 1$ and $\phi 2$), the address bus and the processor SYNC output. Lines 5 and 6 are the control lines to a one-of-four multiplexer. Line 7 shows the state of the multiplexer selected by the two control signals MUX1 and MUX2. Lines 8 and 9 are the row address strobe (RAS) and the column address strobe (CAS), respectively. Lines 10 and 11 show the processor timing requirements for accepting data read out of the memory. Line 12 is the write line (WL) from the 8080 used to enable a memory write into the programmable memory.

16 lines), and the processor SYNC output. Lines 5 and 6 show the control lines MUX2 and MUX1 to a one-of-four multiplexer, and line 7 shows the state of the multiplexer selected by the two control signals MUX2 and MUX1. Lines 8 and 9 show the principle memory timing signals the row address strobe (RAS) and the column address strobe (CAS); lines 10 and 11 show the processor timing requirements for accepting data read out of the programmable memory. The "valid" indication on the waveform of line 10 shows when the eight data lines into the processor must be stable for a successful memory read. The DBIN signal (line 11) is a signal issued by the 8080 to notify the input buffers to turn on in preparation for receiving input data. Line 12 shows the write line (WR) from the 8080 which is used to enable the write operation into the memory.

Working Together

Lines 5 thru 9 of figure 4 constitute the actual memory system design, the result of trading off memory, Altair (S-100) bus and processor parameters, and verifying that all the processor and memory timing considerations are met. The ultimate criterion of a good design is that it can pass a "worst case" analysis — every specification for the 8080 and the programmable memory can be the worst specified in the data sheets, and the system will still work. In fact, a good figure of merit for a digital design involving complex timing (such as this one) is how far *beyond* worst case the specifications can be for the system to still function properly. This is known as margin. The better the margin, the better the designer sleeps at night, and the better guarantee that the system will work over a long production run.

Notice the similarity between $\phi 2$ and RAS (lines 2 and 8) of figure 4. RAS is simply $\phi 2$ with certain positive parts missing. Whenever the 8080 starts an instruction fetch cycle (signalled by SYNC), the RAS line must make its negative transition during MUX state 2 and stay there throughout the memory cycle. If the $\phi 2$ pulse during T2 were allowed through, the memory timing requirements would not be met. To inhibit this $\phi 2$ pulse, SYNC is delayed slightly and used to gate off the unwanted part of $\phi 2$. Notice that this gating signal is MUX1 (line 6). SYNC is delayed very simply by feeding SYNC to the D input of a flip flop and clocking the flip flop with the leading edge of $\phi 1$.

Before this cycle gets underway with row address strobe line RAS dropping, the address lines to the memory must be set up

to receive the low order part of address lines from the processor. The multiplexer must therefore switch from state 0 (the refresh select state) to state 2 (processor-low address state) prior to the fall of RAS. This is accomplished by the signal MUX2, which is turned on by the leading edge of SYNC. This edge gives the address lines more than enough time to settle before they are sampled by RAS.

After the row address strobe part of the cycle is satisfied, the multiplexer switches to state 3 (the other half of the processor address lines), and column address strobe is activated. The column address strobe line goes low when three signals are asserted as follows:

1. $\phi 2$ high.
2. MUX1 high.
3. The bank of programmable memories is selected.

The third control, often called "this memory," performs the chip select function by feeding the column address strobe to only one bank of programmable memories at a time.

Looking now at lines 9 and 10 of figure 4, we can calculate the access time margin of the memory system. The data out of the programmable memory becomes valid sometime after CAS makes its negative transition. The data into the processor must be stable and valid at the time shown in line 10. Counting the time from CAS-low to the earliest time data must be valid, the programmable memory access time should be 6X55 ns (each division is 55 ns), or 330 ns. In a system, this time is reduced by approximately 50 ns to allow for the delays through the data buffers and line settling time. Let us say that the CAS to data access time (CAC) must be 330-50 or 280 ns. The specification for the slowest MK4115 gives a maximum t_{CAC} of 165 ns, a *very* comfortable margin. (If the margin point seems to be overstressed, its importance will be seen in the section on Altair (S-100) bus compatibility).

To complete the cycle, the CAS line must be held low until the processor is definitely through with the data lines. This is indirectly specified in the 8080 data sheet as being the time that DBIN goes high. Since this point is anywhere from 25 to 140 ns after the rising edge of $\phi 2$ in T3, the CAS line is held low until the falling edge of $\phi 2$ in T3. Note that the RAS line makes its low-to-high transition well in advance of CAS's going from low to high. This is permitted in the newer dynamic memory parts but would not be acceptable in the older ones, such

as the MK4096 dynamic 4 K (both column and row address strobes had to go high together). By the time the RAS line makes its next negative transition, the multiplexer has switched back to state 0, selecting the refresh address, and another refresh cycle begins.

The processor access cycle chain of events is initiated by the 8080 SYNC signal. Anytime the SYNC signal is not there, the circuitry automatically reverts to refresh operation. (Multiplexer state 0 selects the refresh counter, the RAS line continuously cycles, and the CAS line remains inactive (high) for the RAS-only refresh operation.) This implements a strategy that maintains refresh on a fail-safe basis.

80 percent of dynamic memory design is printed circuit board layout.

The refresh counter is clocked by a signal which is suppressed during a processor access cycle, so that none of the refresh addresses is skipped. A refinement detail of the design is a flip flop which eliminates some of the redundant refresh cycles to conserve power. This is possible because the latter scheme considerably "over-refreshes" the memory, since a full 128 row refresh is performed in much less time than the 2 ms the specification calls for. Refreshing more frequently than the specification requires has no effect on proper memory operation.

For a write operation, the 8080's write line (WR) is timed such that it can be fed unmodified to the memory's read or write control (RW) pin. The write operation is terminated by the WR line going low to high, or the CAS line going low to high, whichever occurs first.

Figure 5: Supply current waveforms for the MOSTEK MK4116 16 K dynamic memory (courtesy MOSTEK).

Now, the Hard Part

You might think that the design is complete when the final schematic is drawn. Not so: it is about half complete. As any dynamic memory system designer will tell you, *80 percent of dynamic memory design is printed circuit board layout*. These parts don't just sit there like their static counterparts, responding with data whenever addressed. The dynamic part is actually a sophisticated *analog* part inside, aside from being a dense memory array. The circuitry that senses the charge on the storage capacitors must resolve millivolt levels in the presence of continuously running 12 V clocks. The power distribution system and power supply noise decoupling are therefore the most critical elements of a good dynamic memory design. This consideration has killed more dynamic designs than any amount of poor circuit design.

The dynamic memory has four power pins: 12 V, 5 V, ground and –5 V. The 5 V supply is connected only to the output transistors (to provide TTL compatible outputs), and draws next to nothing in power. The –5 V supply provides high current *pulses* of very short durations. Since these pulses are bipolar in nature, the actual DC current for the –5 V supply is also very low. It is the 12 V supply and ground system that need special layout consideration.

The four power pins are located on the four corners of the dual in line package, which somewhat simplifies a good power distribution layout. The best layout for power is one in which all power pins are fed from a horizontal *and* a vertical direction. This is known as "gridded" power distribution, since each power pin is placed at the intersection of a grid of power lines that simulates a plane surface. Wherever possible, the power lines should be as wide as the array density will allow. When density considerations prohibit wide power buses on all four supplies, the 5 V and –5 V supply buses can be fed with smaller traces (but should still be gridded).

The second important consideration is power supply bypassing. The current drawn by the MK4116 is shown in the waveforms of figure 5. Notice that all the current is drawn as a result of RAS and CAS transitions. The factor which sets the MOSTEK 4116 apart from all other 16 K devices is that after the RAS and CAS current demands, the I_{DD} (12 V current) drops to nearly 0. The fact that other parts drop to some continuous current (on the order of

20 mA) when the RAS line and CAS line are inactive (high) accounts for the wide difference in power dissipation between the MK4116 and the others. MOSTEK does it by turning off the sense amplifiers when they are not needed, and the rest of the semiconductor world is presently designing (or redesigning) to duplicate this feature.

Looking at the most critical current waveform of figure 5, I_{DD}, it is seen that the instantaneous current drawn is about 100 mA maximum. 100 mA per device times 32 devices (in a 32 K memory comprised of 8 K parts) is *3.2 A at 12 V*. Before running out to buy a water pump to cool the 12 V regulator, notice that the 100 mA is drawn for only a very brief time. Suppose you connect a capacitor between 12 V and ground, let it charge up during the low current demand time and supply the instantaneous current pulses when needed. This is the role of the so-called "bypass" or "decoupling" capacitors. The value needed for these capacitors can be readily calculated by estimating the area under the curves in figure 5. Using the formula $C=(i\Delta t)/\Delta v$, the capacitance can be calculated for any allowed drop in the 12 V supply (Δv). The MK4116 allows a 10 percent tolerance on all supplies, so a good conservative number to use for the 12 V supply is about 2 percent or 0.24 V. Estimating $i\Delta t$ (the area under one of the current waveforms) from figure 5 to be about 50 ns times 100 mA, the formula yields a value for C of approximately 0.02 μF. (0.1 μF capacitors should work fine.)

The reason for the above exercise is that even though the data sheets may say so, not all dynamic memories are identical. The primary difference between today's dynamic memories is in the current waveforms, and only two manufacturers (MOSTEK and Intel) even publish them.

For the bypass capacitors to be effective, they must be located as close to the memory power pins as possible, so that the inductance of the printed wire feeding the instantaneous current to the part does not interfere with this current supply. Note that for exactly the same considerations as the 12 V supply, the −5 V supply should be adequately "bypassed" with capacitors. The bypass capacitors should be evenly distributed throughout the memory array.

An often neglected detail of dynamic memory layout is that the ground system between the address line drivers and the memory array must be *very* heavy. As the number of integrated circuits in the memory array increases, the requirements on the address line drivers become more stringent. Each address pin contributes a capacitance of about 4 picofarads, and they are all tied together in the array. If you follow any address line through a printed circuit board memory array, you'll see that it takes a rather long and usually discontinuous path. For this reason, series damping resistors should be placed between the address buffers and the memory array to help damp out the undershoot and overshoot caused by the layout discontinuities.

It is quite a trick to achieve optimum power distribution layout on an Altair (S-100) bus format card. The system ground pin comes in at only one corner of the card, and it must be routed in a "web" for a good board level ground distribution. Additionally, the required on board regulators use up a lot of space which, along with the permissible heat dissipation, puts an upper limit on the number of chips that can exist on a card. The message here is that a good memory design requires *extreme* cooperation between the designer and the printed circuit board layout person.

Ah, That "Altair (S-100) Compatibility"

If you have plowed your way through the timing diagrams and technical discussion of this article, you can now appreciate the fact that the question, "Is it Altair (S-100) bus compatible?" is one that cannot be answered with an unqualified yes or no. The memory system is *designed* to be Altair (S-100) bus compatible, but when you plug it into a Stromdecker X-3 mainframe, running a Fantastroid Z-80Q processor card with memory-managed-phantom-indirect-parabolic-vectored-restart implemented, it might not work. The design philosophy is to use as *few* of the Altair (S-100) signals as possible, to account for unforeseen variations in various systems. Back to figure 4: the only timing lines the memory *counts* on being there are ϕ1, ϕ2, SYNC, DBIN (actually MEMR, memory read) and WR (actually memory write). In the case of the memory write line, any Altair (S-100) design should *derive* the memory write signal from SOUT and WR, since early designs put the gate to do this on the front panel board, and you therefore cannot guarantee that the signal MEMW will be there in all systems.

Some analysis of the interlocked timing of figure 4 reveals that the card will work with any implementation of ϕ1 and ϕ2 *that meets the 8080 specifications.* The ϕ1 and ϕ2 timing shown in figure 4 is that

Imagine pulling out four 8 K static memory cards and plugging in a single 32 K card that uses less power than *one* of the 8 K cards. This can be done with today's dynamic memories.

provided by systems using an 8224 clock generator with an 18 MHz crystal; this is the most popular Altair (S-100) implementation. Will it work with Z-80 processor cards? Maybe. The Z-80 requires only a single clock, has no SYNC output, and times its read and write operations slightly differently than the 8080. Designers of Z-80 based Altair (S-100) cards realize that there is a big compatible world out there that they must back into, so they attempt to synthesize 8080-type signals out of the Z-80 system timing. How successfully they emulate the 8080 (meaning how accurately they reproduce signals such as $\phi1$, $\phi2$ and SYNC) determines the degree of compatibility in a system of Altair (S-100) cards.

Incidentally, a final look at figure 4 illustrates the elusiveness of the memory "access time" specification. How many times have you seen ads that say something like "300 ns memories," and wondered what this actually means in an 8080 system? Figure 4 shows that the access time is not itself a figure of merit. The actual memory timing must be compared with the *system* timing requirements to make any sense. The general idea in a dynamic memory design is to crowd the multiplexing of row and column address strobe events as close as possible to the processor addresses becoming valid, so that the maximum memory access time is allowable. One thing *is* certain — faster memories always cost more than slow ones, so a cost effective design should accommodate the slowest available. The access time margin is so wide in figure 4 that the system could actually run much faster and still retain comfortable margins.

Final Thoughts

The design presented here is intended primarily to show the important areas of consideration in a dynamic memory design. The general concepts can be applied to any processor and memory interface, using the same methodology of carefully analyzing the specific timing requirements of the system and the programmable memory components, and then merging the two together. Exactly how this is done is the exciting part of digital design, where the designer can be creative. It is most important to first examine the system requirements and keep the memory faithful to these specifications.

A dynamic design pays handsome dividends in a system. By using low power Schottky TTL (74LS family), the 5 V current requirement is kept so low that the 5 V regulator on the card does not even need a heat sink. The 12 V regulator requires a modest heat sink. The total power requirement of the board can be generally less than any static board, regardless of density. Imagine pulling out four 8 K static cards and plugging in a single 32 K card which uses less power than *one* of the 8 K cards. This type of performance is possible only with today's high performance dynamic memories.■



Good bye ATLANTIC CITY

HELLO PHILADELPHIA



The Largest Personal Computing Show Ever Held

ONLY MAJOR EAST COAST SHOW IN '78

August 25, 26, 27th at the Philadelphia Civic Center

300 + Booths
80 Hours of Free Seminars
Art Show
Music Festival
Banquet

THREE FULL DAYS OF FUN

As of May 11, 1978 the following companies have selected their booth locations. Over 200 exhibitors expected at the only Major East Coast Personal Computing Show of the year.

INTERFACE AGE MAGAZINE, HEATH COMPANY, BYTE MAGAZINE, MICROAGE, ITHACA AUDIO, ARTEC ELECTRONICS, COMPUTER MART OF NEW JERSEY, SUMMAGRAPHICS, PERSONAL COMPUTER CORP., TELPAR, VECTOR ELECTRONICS, BITS BOOKS, SOUTHWEST TECHNICAL PRODUCTS (SWTP), CROMEMCO, TECHNICAL DESIGN LABS, HAYDEN BOOKS, DIGITAL EQUIPMENT CORP., OSBORNE & ASSOCIATES, OHIO SCIENTIFIC INSTRUMENTS, RAMSEY ELECTRONICS, MIDWEST SCIENTIFIC INSTRUMENTS, COMPUTER MART OF PENNSYLVANIA, ADVANCED COMPUTER PRODUCTS, PAGE, SELECTRONICS, PROCESSOR TECHNOLOGY, THE DIGITAL GROUP, CREATIVE COMPUTING MAGAZINE, RADIO SHACK, ALPHA MICRO SYSTEMS, TECHNICAL SYSTEMS CONSULTANTS, NORTHERN VALLEY SYSTEMS, COMPUTER RETAILING, E & L INSTRUMENTS (SHORTESS & RAWSON), NORTH STAR, MARKETLINE, COMPUTER RESOURCES, NBC IMPORTS, E. BERG PUBLICATIONS, EXTENSYS, DILITHIUM PRESS, EXPANDOR, MICROSETTE, NATIONAL MULTIPLEX, JADE, COMPUTER EMPORIUM, NEWMAN COMPUTER EXCHANGE, MICRO TECHNOLOGY UNLIMITED, MICRO COMPUTER DEVICES, RADIO ELECTRONICS MAGAZINE, PARASITIC ENGINEERING, COMPUTER ENTERPRISES, ARRL, COMPUTER TEXTILE, BASIC BUSINESS SYSTEMS, MICRO COMPUTER PRODUCTS, S.D. SALES, COMPUTALKER, COMPUCOLOR, TECHNICO, POLYMORPHIC SYSTEMS, WILLIAM ELECTRONICS, MODULAR SYSTEMS INC., ENCLOSURE DYNAMICS, MICROPOLIS, RICO ENTERPRISES, OBJECTIVE DESIGNS, SYBEX, ELECTRONIC CONTROL TECHNOLOGY, APPLE COMPUTER, MANCHESTER EQUIPMENT.

DAYTIME EVENTS • New Products • Demonstrations • Personal Computing College • Exhibits • Art Show • Join Clubs at The Club Booth • User Group Meetings

EVENING EVENTS • User Group Meetings • Parties • Music Festival • Banquet, Saturday, August 26, featuring Dr. Adam Osborne, Chris Morgan, Editor of Byte and more . . . Stay over and enjoy the evening events.

Deluxe hotel accommodations with rates starting at $24 single, $31 double with **free shuttle bus** to and from Philadelphia Civic Center. Bring the family • Visit Historic Philadelphia • Have an unforgettable Philadelphia experience, pre-register before August 10th and save time and money (20%).

See our ad on page 81.

Send ______ 3 Day Registrations @ $8 each, $10 at Door.

Send ______ Banquet Tickets @ $17.50 each.

Total Enclosed ______

☐ Send Hotel information.

☐ Hold my registration and Banquet Tickets for pick-up at the convention.

NAME ______

STREET ______

CITY ______ STATE ______ ZIP ______

PHONE ______

Send To:

PERSONAL COMPUTING 78

Rt. 1 Box 242 • Mays Landing, N.J. 08330

BYTE

Circle 302 on inquiry card.

Ted Williams
Steve Conley
Dept of EE
University of Arizona
Tucson AZ 85721

A High Level Language for 8 Bit Machines

I	**Assignment**	
	A. VAR = exp	Variable VAR is set to the value of the expression on the right side of the equal sign.
II	**Branch**	
	A. **IF** β VAR relation exp	The code following, up to the corresponding ENDIF, is executed only if the variable value satisfies the relation.
	B. **ENDIF**	Indicates the portion of code to be executed if the earlier IF statement is satisfied.
III	**Loop**	
	A. **DO**	The code between a DO and an ENDDO is executed repetitively until the variable satisfies the inequality. More than one UNTIL may be included in one DO loop.
	B. **UNTIL** β VAR relation exp	
	C. **ENDDO**	
IV	**Subroutine**	
	A. **CALL** β NAME	A CALL executes the code following the SUBROUTINE statement with the same name until a RETURN is encountered.
	B. **SUBROUTINE** NAME	
	C. **RETURN**	
V	**Input and Output**	
	A. **READ** β channel, VAR1, VAR2, . . .	READ specifies a transfer from the device specified by channel, conversion to floating point, and transfer to the locations in memory specified by the variable names.
	B. **PRINT** β channel, { VAR / quotes / ! }	PRINT sends data to a specified output device in binary coded decimal form, prints ASCII code between quotes, and sends a carriage return for each "!".
VI	**Leaving Interpreter**	
	EXIT	Causes the interpreter to return to the monitor.

Table 1: The interpreter instruction set allows the evaluation of expressions, conditional branches, loops, subroutine calls with multiple returns, and IO instructions. Keywords are indicated by boldface type in this table. The variable names must contain six or less alphanumeric characters and start with a letter. Expressions (exp) may contain numbers, operators, variables, functions and parentheses. Any of the following relations may be used: >, > =, <, < =, =, > <. β indicates mandatory space. All other spaces are ignored by the interpreter. The only limit to the number of loops that may be nested is the amount of memory space available for storage on the stack. Everything past a semicolon on a line will be ignored as a comment. Each statement must be terminated with a carriage return.

Interpreters such as BASIC or APL do not translate the high level source code into machine language. Rather, they scan the line of code and then perform a set of operations based upon the instruction and data stored in tables from previous instructions. Thus an interpreter saves the time consumed by translation, but no machine code is saved for later execution. The main advantage of an interpreter is the ease of error correction. The results of each line of code can be printed and the exact source of difficulty can be pinpointed. The price paid for this feature is memory. The source code, data, tables and the interpreter program must all be resident in memory at the same time.

Programs also run slower because the code within loops must be reinterpreted on each pass.

The language proposed here is suitable for use with both an interpreter and a compiler. If both are available then the time consuming process of compiling is avoided until permanent machine level code is required; furthermore, the debugging of a developing program may be done quickly and easily with an interpreter in an interactive mode.

The purpose of this article is to introduce readers to concept interpreters and to present an example of an interpreter for a high level language.

The interpreter instruction set is shown in table 1. In addition to evaluating expressions, the interpreter can also perform conditional branches, loops, subroutine calls with multiple returns, and IO instructions. These instructions are sufficient to execute very complex tasks. In fact, the language is devised to encourage a top down approach to writing code so that it is easy to understand, debug and modify. More complex groupings such as an IF THEN ELSE construction might yield slightly shorter programs if included in the language, but the convenience of using such structures does not seem to warrant the considerable effort required for implementation. Good programming techniques are essential to useful code.

Some other simplifications are made just to simplify this interpreter. No integer variables, arrays, complex variables or double precision variables are included. All numbers are considered to be floating point numbers with a 4 byte mantissa and a 1 byte exponent. Also the subroutine calls do not pass arguments. Since all the variables are global symbols, local variable names within a subroutine may not duplicate those in another routine. These restrictions are made so that the code for the interpreter would fit on a small machine and so that the main features of the interpreter will not be obscured.

The interpreter program is written in terms of a universal set of instructions, MACL1. These macroinstructions can be translated into machine code instructions for a variety of microprocessors if the expansions for each macroinstruction are defined for your microprocessor. The translation of the interpreter into machine code is simplified by the use of a program called a macroprocessor. Otherwise it can be done by hand.

High Level Language Statements	Notes
AREA=0 X=1 Y = (X↑2) + (2*X)+3 DELTX=0.1	initialization
IND=11	loop condition counter is "IND"
DO	start of DO loop
X=IND*0.1	
YPLUS=(X↑2)+(2*X)+3 AREA=AREA+DELTX* (YPLUS+Y)*0.5	; sum areas using trapezoidal integration rule
UNTIL IND>=100	UNTIL evaluates loop reiteration condition
IND=IND+1	
ENDDO	ENDDO tests loop reiteration condition
PRINT 1, "The area is", AREA	output message and AREA through channel 1
EXIT	go back to monitor
END	

*Listing 1: This example program, written in the high level language of this interpreter, is a trapezoidal integration routine for the function Y=(X↑2)+(2*X) 3.*

```
P2=3.14159*0.005
READ 2,A
IF          A<SIN (P2)
            PRINT 1,A "A IS TOO SMALL",
            EXIT
            ENDIF
IF          A>SIN(100*P2)
            PRINT 1,A, "A IS TOO BIG",!
            EXIT
            ENDIF
LOW=1
HI=100
DO
            UNTIL HI<=LOW+1
            MID=INT( (HI+LOW) /2)
            IF A>SIN(P2*MID)
                    HI=MID
                    ENDIF
            IF A>SIN(P2*MID)
                    LOW=MID
                    ENDIF
ENDDO
IF A=SIN(P2*LOW)
            HI=LOW
            ENDIF
IF A=SIN(P2*HI)
            LOW=HI
            ENDIF
XLOW=SIN(P2* LOW)
XHI=SIN(P2*HI)
PRINT 1,XLOW,XHI,A
EXIT
END
```

Listing 2: This example program gives the flavor of a longer program with references to various mathematical routines. Indentation is done to emphasize program structure.

The following sections discuss the implementation of each of the five types of instructions and show the function of the instructions in flowchart form. Two examples shown in listings 1 and 2 illustrate the simplicity of the resulting high level language.

Interpreter Organization

The basic elements of the interpreter and the utilization of memory are shown in figure 1. Besides the source code and the interpreter routines, there are four tables, two stacks and a workspace for control pointers. The workspace is used for pointers to keep track of positions in the various tables, limiting addresses for the tables, scratch area for temporary results, and addresses for IO channels.

The stacks are used for saving subroutine return addresses and for evaluating equations as described in our discussion of the assignment operations section. The four tables are for remembering:

1. where previously defined variables are stored.
2. where subroutines are located in the source code.
3. where subroutines are located in the interpreter code.
4. the location of routines to perform the operations (+, –, *, /, ↑) and functions defined for this language.

The tables are searched by a linear search routine which starts with the portion of the table most likely to contain the item. The ASCII byte string in the name list is compared with the desired name. The end of a name or symbol in the table is denoted by a

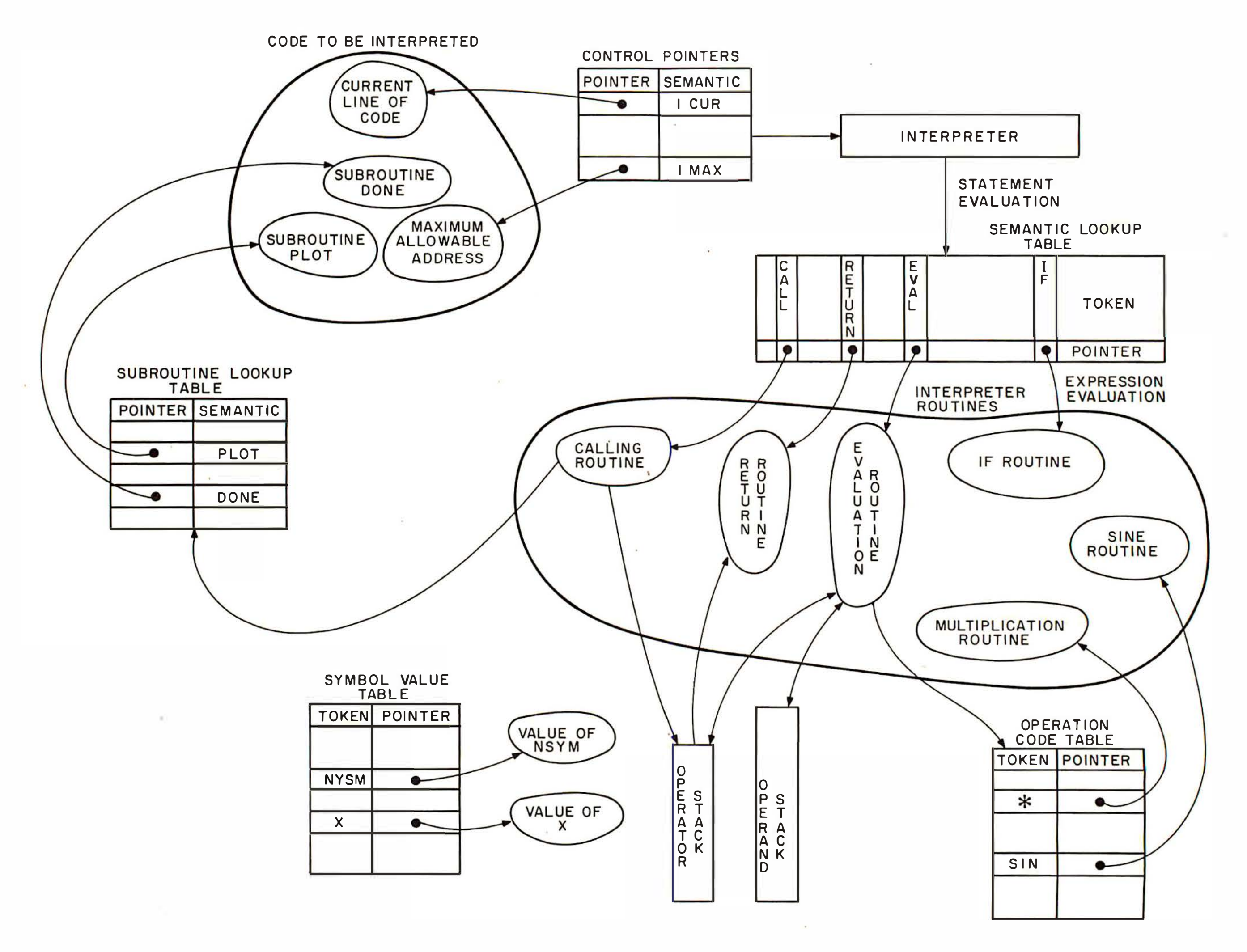


Figure 1: A map detailing the utilization of memory by the interpreter. Part of the memory consists of four tables that are used to look up values of previously used variables, locations of subroutines in source code, locations of machine language subroutines for the interpreter, and locations of routines for symbols and functions defined by the interpreter. The two stacks are used in the parsing of equations and when a subroutine is called or returned from. The two largest areas of memory contain the source code and actual machine code for the interpreter.

one in the most significant bit, called a terminator. When a terminator is reached in the name list, the pointer in the corresponding address table or value table is incremented to the next item. When a name is found, the pointer in the corresponding list points to the location where the value for the symbols table or the address is located. The desired name or symbol is always added to the list to make sure that the search does not run off the end of the table. After the search, the name pointer can be checked to see if the search went beyond the current length of the list. This technique is faster than putting an end check into the search routine.

The subroutines in the high level source code are not the same as the routines used by the interpreter for performing operations and functions. The first set of subroutines contain source code and the second set contain machine code for operations executed by the interpreter.

Interpreter Operation

Initialize: The initialize portion of the interpreter has two functions. It loads the source code from a peripheral and it initializes the workspace. As it loads, it also scans the source code looking for subroutine statements. The name of each subroutine is put into the subroutine name table, and the corresponding position in the code is put into the subroutine address lookup table shown in figure 1. The initialize routine is entered from the system monitor, and the initialize routine returns control to the system monitor.

Scan: The scan portion of the interpreter receives control from the monitor and scans the code starting from the current contents of the line pointer. Depending upon which of the 12 instructions of table 1 is encountered, this routine jumps to one of the routines as shown in figure 1 in order to execute one line of code. If an end of file (EOF) character or an error is encountered, the scan routine transfers back to the monitor for text editing, reloading or further execution.

A trace option is included in the scan routine which prints the name and value of all assignment statements as they are executed. This option is included for debugging and tutorial purposes.

Assignments: If the scan routine detects an assignment statement then the interpreter jumps to the EQN routine of figure 2. The EQN routine operation is outlined in table 2 as a list of operations and operands.

The EQN routine uses the routine EVAL

Operation	Operand	Description
.JSR	lgvarad	; Get variable address. Use current line pointer to fetch variable name. See if name is in name table. If it is, transfer its address to (wptr). If it is not, add name to table. Transfer symbol address from symbol value pointer to workspace at (wptr). Update the line pointer up to the equal sign.
.JSR	leval	; Subroutine EVAL evaluates the right side of the expression and returns the value on the stack.
.POP	wdeval	; Put result from EVAL call into workspace.
.MOV	(wptr), wdeval	; Transfer the result from EVAL call to the location specified by the contents of (wptr).
.JSR	lfinstm	; Scan the rest of the line of code skipping over the comment field up to the carriage return and update the current line pointer.

Table 2: An outline of the EQN routine. The routine first gets the variable address, then evaluates the right side of the expression and puts the value into the workspace. It then skips over the comment field to the carriage return, updates the line pointer, and decodes the next line of code. This outline flows from top to bottom, with the "operations" and "operands" intended to be used with a macroassembler.

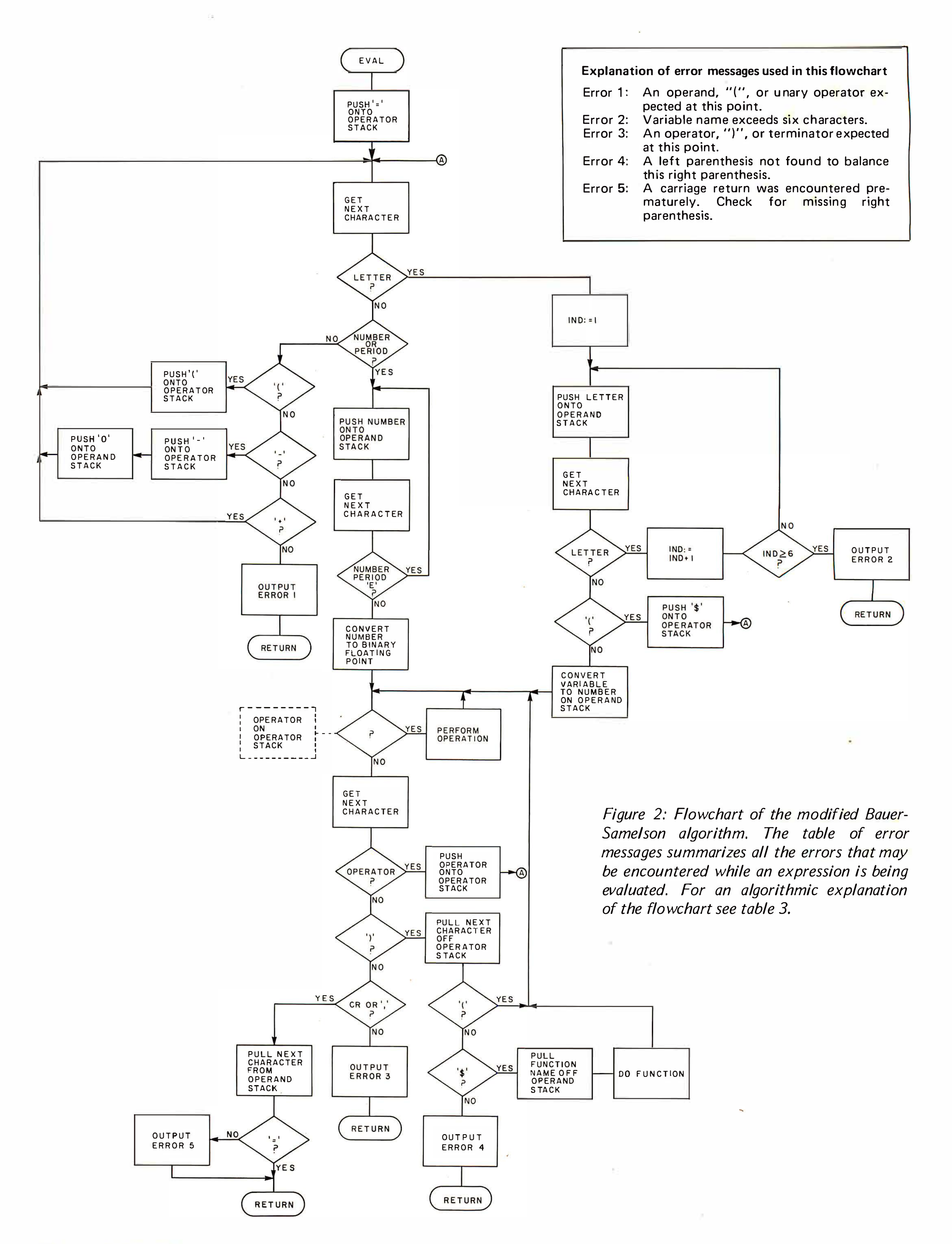
L1 mode: In this mode an operand, unary operator, left parenthesis, or function is expected.

If this token type is received	Then perform operation
operand:	stack the operand. If the operator stacked is not a "(", perform the indicated binary operation. Proceed to mode L2.
operator:	must be unary. Stack operator and stay in mode L1. Push a 0 onto the stack if operator is a minus sign.
function:	push variable near operand stack. Push $ onto operator stack to indicate a function. Stay in mode L1.
right parenthesis:	error.
left parenthesis:	push it onto operator stack. Stay in mode L1.

L2 mode: In this mode an operator, right parenthesis, or carriage return is expected.

If this token type is received	Then perform this operation
operator:	push operator onto stack. Go go mode L1.
operand:	error.
left parenthesis:	error.
right parenthesis:	pull operator from stack. If it is a "(" unstack it and return to mode L2. If it is a $ perform the function, then return to unstack operation.
carriage return:	check operator state. Operand stack should have exactly one value. Convert value to floating point. Return to EQN routine.

Table 3: The Bauer-Samelson algorithm to determine the order of operation of an expression. The algorithm starts in the L1 mode looking for an operand. The execution of the expression starts in the innermost parenthesis and works from left to right without any consideration for precedence.



Explanation of error messages used in this flowchart

Error 1: An operand, "(", or unary operator expected at this point.
Error 2: Variable name exceeds six characters.
Error 3: An operator, ")", or terminator expected at this point.
Error 4: A left parenthesis not found to balance this right parenthesis.
Error 5: A carriage return was encountered prematurely. Check for missing right parenthesis.

Figure 2: Flowchart of the modified Bauer-Samelson algorithm. The table of error messages summarizes all the errors that may be encountered while an expression is being evaluated. For an algorithmic explanation of the flowchart see table 3.

Equation: X = +4.↑ VAR (CR)

Present Mode	Character Obtained	New Operand Stack	New Operator Stack
L1	+4.	4	=
L2	↑	4	=,↑
L1	VAR	4,VAR	=,↑
L1	(unstack)	4↑VAR	=
L2	CR	4↑VAR	

Equation: X = (+4* – VAR + COS(SIN(–Y))) (CR)

Present Mode	Character Obtained	New Operand Stack	New Operator Stack
L1	(		=,(
L1	+4	+4	=,(
L2	*	+4	=,(,*
L1	–VAR	4,0,VAR	=,(,*,–
L1	(unstack)	(4*–VAR)	–,(
L2	+	( )	=,(,+
L1	COS(	( ),COS	=,(,+,$
L1	SIN (	( ),COS,SIN	=,(,+,$,$
L1	–Y	( ),COS,SIN,0,Y	=,(,+,$,$,–
L1	(unstack)	( ),COS,SIN,(–Y)	=,(,+,$,$
L2	)	( ),COS,SIN(–Y)	=,(,+,$
L1	(unstack)	(no change)	
L2	)	( ),COS,(SIN(–Y)	=,(,+
L1	(unstack)	( )	=,(
L2	)	( )	=
L1	(unstack)	no change	
L2	CR	exit	

Listing 3: Two examples of parsing done by the EVAL routine. The first equation is performed sequentially from left to right since there are no parentheses to change the order of execution. The second expression contains parentheses to modify the order of execution. The first operation performed is the sine of –Y. The cosine of that value is then determined. The value of VAR is then subtracted from that value and added to +4. The symbol ↑ is used to designate exponentiation.

to evaluate the right side of the equation, then the value returned on the operand stack is transferred to the location assigned the variable. The FINSTM routine skips over any comment field up to the carriage return.

EVAL: The EVAL routine uses a slightly modified Bauer-Samelson algorithm to determine the order of execution of an expression. *[For a thorough discussion of this method see February 1976 BYTE, page 26.]* The execution starts in the innermost parentheses and works from left to right without any consideration for precedence. Since many different types of precedence have been used in other languages, confusion is likely. This procedure minimizes the size of the stack and conforms with the conventions of APL and most assemblers. Precedence is established by parentheses which make the ordering unambiguous.

The algorithm is shown in table 3 as an action table with two modes L1 and L2. The algorithm starts in the L1 mode, expecting an operand, which is a variable or a name. If an operand is found, the algorithm goes to the L2 mode, expecting an operator. After an operand is found, any operators at the top of the operation stack are executed. A flowchart of the algorithm is shown in figure 2.

Two examples of parsing by EVAL are shown in listing 3. The ↑ symbol is used for exponentiation. In mode L1, the + and – are considered unary operators, but if they are encountered in mode L2 they are considered binary operators. This distinction is the rationale for operating in the two modes. The errors described in the table of figure 2 cause the interpreter to terminate execution, print the line of code up to the error, and print an error message indicating the difficulty.

IF: The routine shown in figure 3 first compares the variable with the expression and then the interpreter executes the code up to the corresponding ENDIF statement, but only if the variable meets the conditions specified by the IF statement. This routine uses the EVAL and SEARCH routines.

A flowchart of the SEARCH routine is

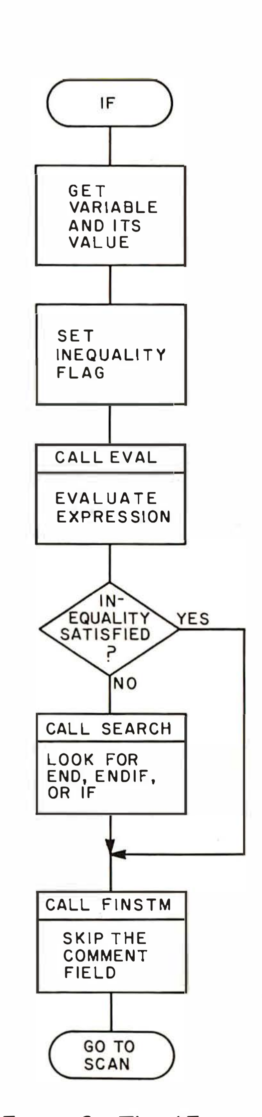


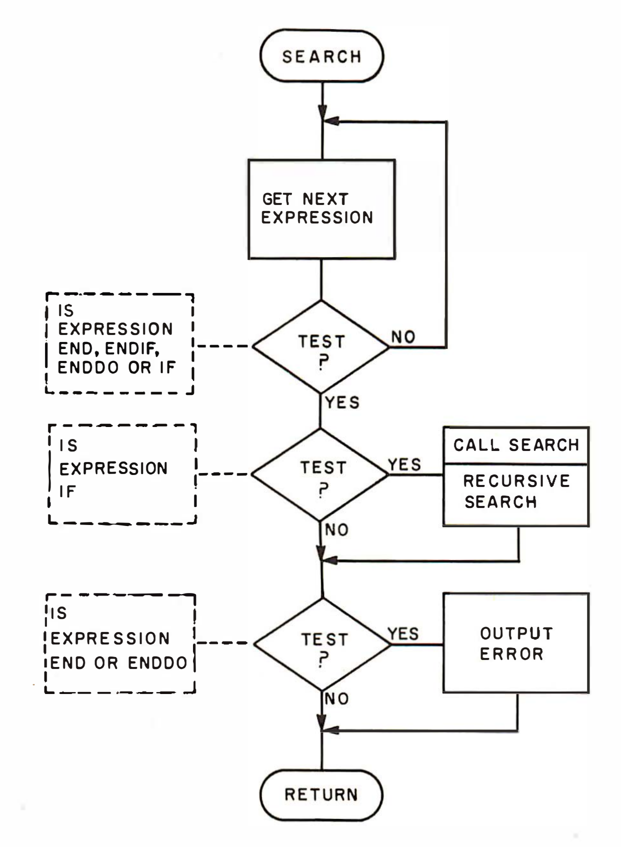
Figure 3: The IF routine evaluates the expression and then checks to see if the inequality has been satisfied. If the inequality is not satisfied it will perform the operations between the IF statement and the line containing the ENDIF statement. If the inequality is satisfied then the interpreter skips over the instructions and goes to the line of code directly after the ENDIF statement.

shown in figure 4. The SEARCH routine scans the line of code trying to find an ENDIF statement. If another IF statement is encountered the subroutine calls itself to try to first find another ENDIF before it goes back to searching for the first ENDIF. If one ENDIF statement is not found for each IF before an END or ENDDO statement, an error is announced.

An IF and its corresponding ENDIF may not straddle an ENDDO. If this were allowed, the data stored on the stack by the DO loop might not be unstacked as the DO loop is exited.

Search: Each line of code is inspected until an END, ENDIF or IF is encountered. An IF causes the search to initiate another search for an ENDIF, an END causes an error, and an ENDIF causes a return.

Figure 4: The SEARCH routine inspects each line of code until an END, ENDIF or IF command is encountered. An IF statement causes the search to initiate another search for an ENDIF. Note that this means that the routine will be calling itself recursively, so care must be taken in allocating and preserving local data within SEARCH during recursion. An END statement causes an error and an ENDIF statement causes a return from the SEARCH routine.



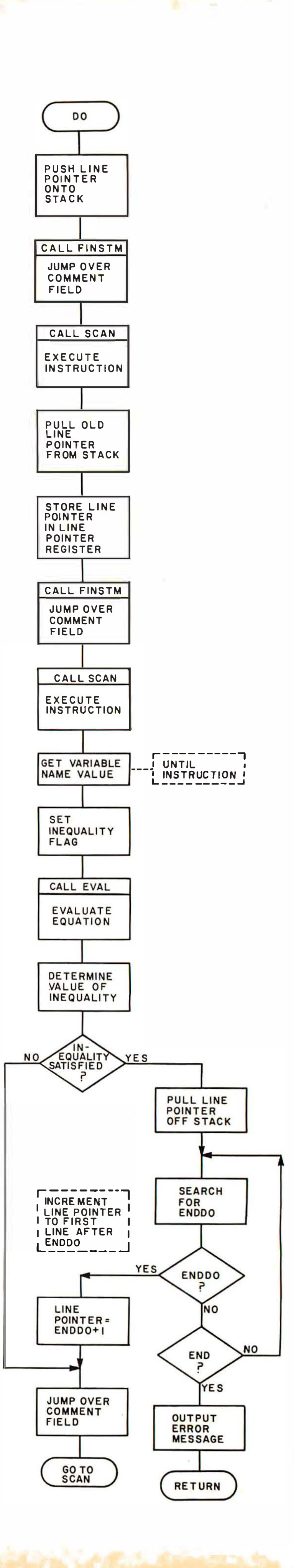
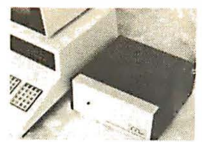


Figure 5: The DO routine will perform the operations between the line of code containing the DO statement and the line of code containing the ENDDO statement until the inequality is satisfied. When the inequality is satisfied the interpreter will exit the DO loop and perform the first line of code that follows the ENDDO statement. →

***** 15359 BYTES FREE *****



INTERNATIONAL TECHNICAL SYSTEMS

Proudly announces the

PEM-8K

8K OF ADDITIONAL MEMORY FOR YOUR PET®

- COMPLETELY ASSEMBLED AND TESTED
- BUILT-IN HEAVY DUTY POWER SUPPLY
- ATTRACTIVE ENCLOSURE
- COMPATIBLE WITH 4K OR 8K PET®
- NO MODIFICATIONS REQUIRED

Introductory BONUS SOFTWARE PACKAGE: 10K of Financial, Mathematical and Algebraic Programs

Shipped postpaid — — Price: $279.

(Virginia Residents Add 4% Sales Tax)

INTERNATIONAL TECHNICAL SYSTEMS
P.O. Box 264
WOODBRIDGE, VIRGINIA 22194

Circle 187 on inquiry card.

P.E.T. Food

Creative Software offers a wide range of programs on cassette tapes for 8K PETs:

HOUSEHOLD FINANCE Parts I and II.........$15.00
SPACE WAR - Adapted for the PET...........$10.00
HOUSEHOLD UTILITY PACKAGE #1...........$10.00
GAMEPAC #1 - Five games for the PET.....$12.00

Add $1.00 per program packing and shipping.

Introducing A LOW PRICED **Joystick!**
Plugs right into the PET with no modifications or assembly. Comes with two programs.

JOYSTICK - With MAZE and SKETCHPAD...$35.00
STAR WARS SHOOTOUT - For the joystick....$10.00

Add $2.50 packing and shipping for JOYSTICK.

Write for more information and a complete list of currently available programs.

Creative Software
P.O. Box 4030 Mountain View, CA 94040

MASTERCHARGE AND VISA ACCEPTED
California residents add 6% sales tax

Circle 78 on inquiry card.

COMPUTER MART OF MASSACHUSETTS

Featuring a wide variety of program development systems.

XITAN[TDL] DISK BASIC $159

Now available for Z-80 based systems running CP/M.

Ask us about the new **XITAN GENERAL.**

COMPUTER MART OF MASSACHSETTS
1097 Lexington St. Waltham, Ma. 02154
(617) 899-4540

Circle 74 on inquiry card.

HOME COMPUTER APPLICATIONS

Quantum Science Corporation, a major multinational consulting firm is looking for an imaginative individual for our consulting staff who will enjoy analyzing and conceptualizing the impact of microprocesors, personal computers, and low cost semiconductor technology on entertainment, information, and control products/systems in the home. Applications of these technologies in small businesses will also be explored.

Please send resume or a letter to

E. J. Gladstone,
Director CEIS
Quantum Science Corporation
245 Park Avenue
New York, NY 10017
An Equal Opportunity Employer

Circle 306 on inquiry card.

CATCH-A-PULSE II®
LOGIC PROBE



- 10 Nsec pulse response
- Open circuit detection
- Replaceable tip & cord
- High input impedance
- Pulse stretching
- Multi-family

10 Nsec SPEED AT 3.5 to 15V LEVELS ONLY **$39.95**

Compatible with RTL, DTL, TTL, CMOS, MOS, and Microprocessors using a 3.5 to 15V power supply. Thresholds automatically programmed. Automatic resetting memory. No adjustment required. Visual indication of logic levels, using LEDs to show high, low, bad level or open circuit logic and pulses. Highly sophisticated, shirt-pocket portable (protective tip cap and removable coil cord). Eliminates need for heavy test equipment. A definite savings in time and money for engineer and technician.

Send $39.95 (Calif residents add 6% sales tax) to: Pat Pend Dealer inquiries welcome

AP ELECTRONICS
Box 19299, San Diego, CA 92119, (714) 447-1770

Circle 16 on inquiry card.

6800 OWNERS

At last a real world *fully addressable* SS-50 control interface. Control robots, appliances, organs, solar devices, etc. Applications limited only by your imagination. Easy to use with machine language as well as basic. Fully buffered board plugs directly onto mother board and responds to any address defined by user. 8 fast relays latch data while 8 opto-isolators allow handshaking capacity.

Kit $98.00
Assembled and tested $125.00

Visa & Master Charge
Shipped pre-paid

TRANSITION ENTERPRISES INC
Star Route, Box 241
Buckeye AZ 85236

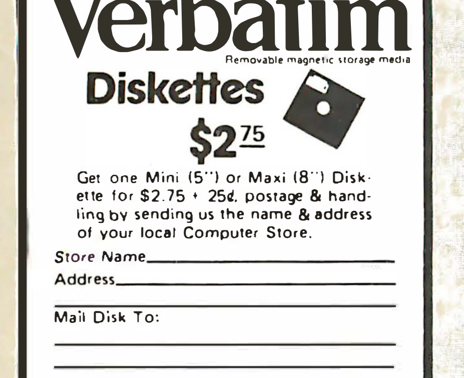
Circle 377 on inquiry card.

Verbatim

Removable magnetic storage media

Diskettes
$2.75

Get one Mini (5") or Maxi (8") Diskette for $2.75 + 25¢ postage & handling by sending us the name & address of your local Computer Store.



Store Name______
Address______

Mail Disk To:

MINI: 0 10 16 MAXI: Hard Soft

Systems______



Computer Resources Company
1437 Gordon Street
Allentown, PA 18102 C72

Circle 77 on inquiry card.

CANADIANS

Announcing

HAMILTON LOGIC SYSTEMS

Specializing in logic devices, microprocessors, memorys, TTL, Cmos, etc.

Send for your catalogue

Box 7
STONEY CREEK
ONTARIO L8G 3X7

Circle 153 on inquiry card.

Araeco
TPR-1



THE ULTIMATE IN:

OPTICAL TAPE READERS

Precision machined tape guide
Interface directly to a PIA or UART
Tri-state buffer output
All handshake logic - TTL compatable
Pull thru tape - Reads 0 to 5000 cps
Interface thru a 14 pin IC plug (PROVIDED)

TPR-1 ASSEMBLED & TESTED $42.50*
HSA-1 PLUG-IN HANDSHAKE ADAPTER $7.50*

*WISCONSIN RESIDENTS ADD 4% SALES TAX.

TO ORDER, SEND CHECK OR M.O. TO:

MICROCOMP P.O. BOX 1221 FOND DU LAC, WI 54935

WE SPECIALIZE IN MICROCOMPUTER SYSTEMS FOR HOBBY - BUSINESS - EDUCATION
WE ARE EXCLUSIVE OSI DEALERS...
... WE DO A BETTER JOB.

- KITS - FULL SYSTEMS - PERIPHERALS - FLOPPY DISKS - ACCESSORIES -
- DIGITAL CLOCK KITS - VIDEO TERMINALS - BOOKS - MAGAZINES -
SEND FOR FREE CATALOG TODAY!!!

Circle 223 on inquiry card.

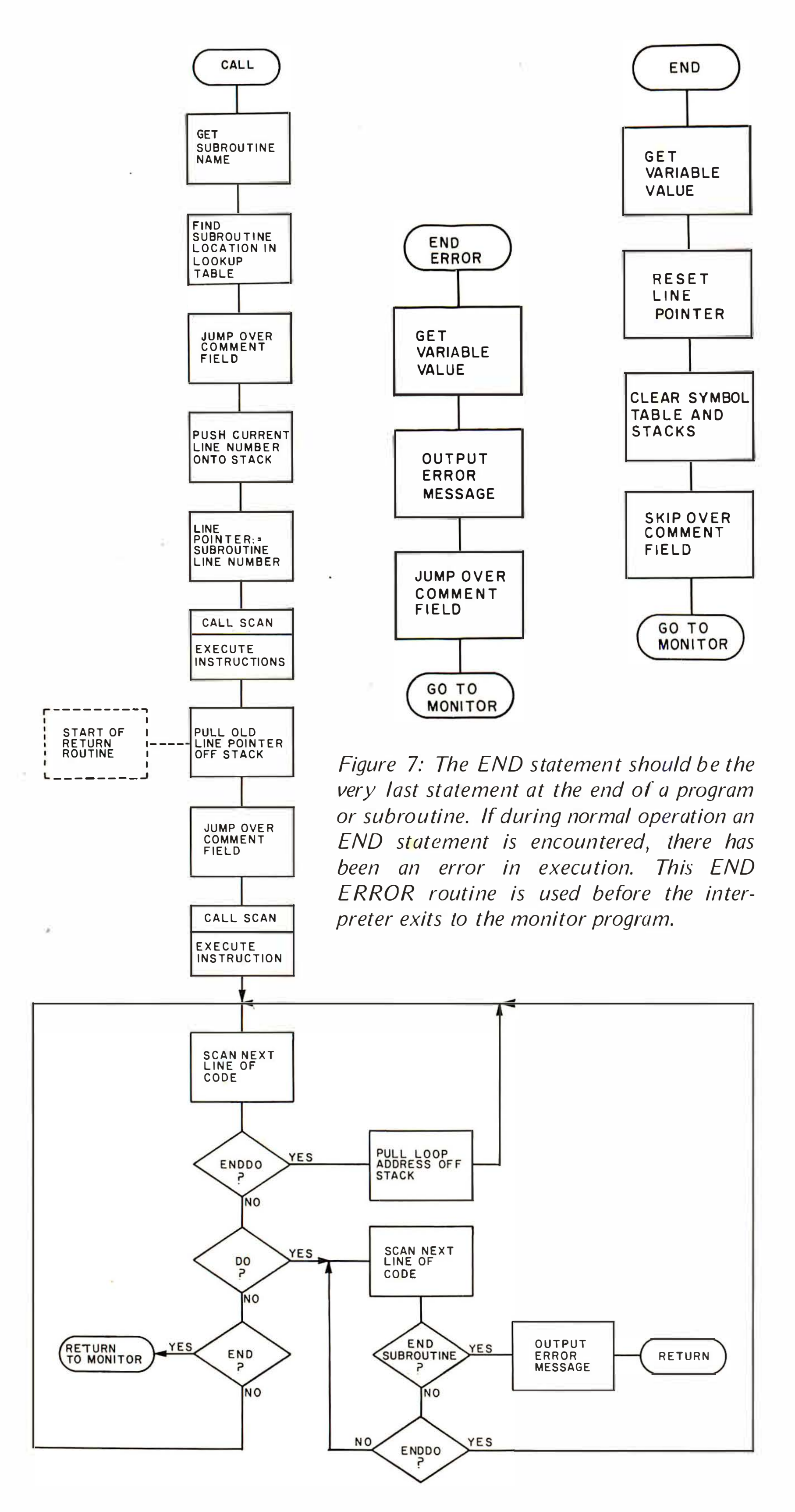


Figure 7: The END statement should be the very last statement at the end of a program or subroutine. If during normal operation an END statement is encountered, there has been an error in execution. This END ERROR routine is used before the interpreter exits to the monitor program.

Figure 6: Flowchart for the CALL and RETURN routines. The interpreter allows multiple return statements and allows the subroutine to have a return from within a DO loop. Subroutines may be nested with the only limit being the amount of memory space that is available for use by the stack.

Figure 8: The EXIT routine transfers control back to the monitor program. The line pointer is reset to the beginning of the program, the stacks are reset to their original values, and the symbol table is cleared.

←

DO: The flowchart of the DO routine is shown in figure 5. The DO loop routine stores the line pointer on the stack. The line pointer will be used later by the ENDDO macroinstruction to determine where to return in the source code. The use of a stack allows nested DO loops. The lack of statement labels excludes the possibility of errors caused by not nesting DO loops within each other (which is possible in a language like FORTRAN).

The UNTIL instruction provides the means of exit from a DO loop. When the variable satisfies the inequality, the program moves to the code past the next ENDDO statement. For a DO loop of fixed length the variable must be initialized prior to the DO statement and incremented within the loop.

Subroutine Call: The CALL routine shown in figure 6 determines the location of the subroutine code in the code list by looking up the location in a table. The table of locations is built for later use during the initialization process before any code is executed. The location of the current position in the code is saved in the stack. Usually the operand stack is used.

The RETURN routine recovers from the subroutine by loading the old line address from the stack into the line pointer. A RETURN from within a DO loop presents a special problem which is resolved by searching for any lone ENDDO statements and pulling the loop address off of the stack.

END and EXIT: The END routine is shown in figure 7. The END routine denotes the end of the program or subroutine. Its main purpose is to prevent the program execution from proceeding into another routine, causing an error.

The EXIT routine shown in figure 8 is responsible for transferring control back to the monitor and mopping up chores such as resetting the line pointer to the beginning, resetting stacks, and clearing the symbol table. It normally would not clear the subroutine table as the code may be rerun later.

Conclusion

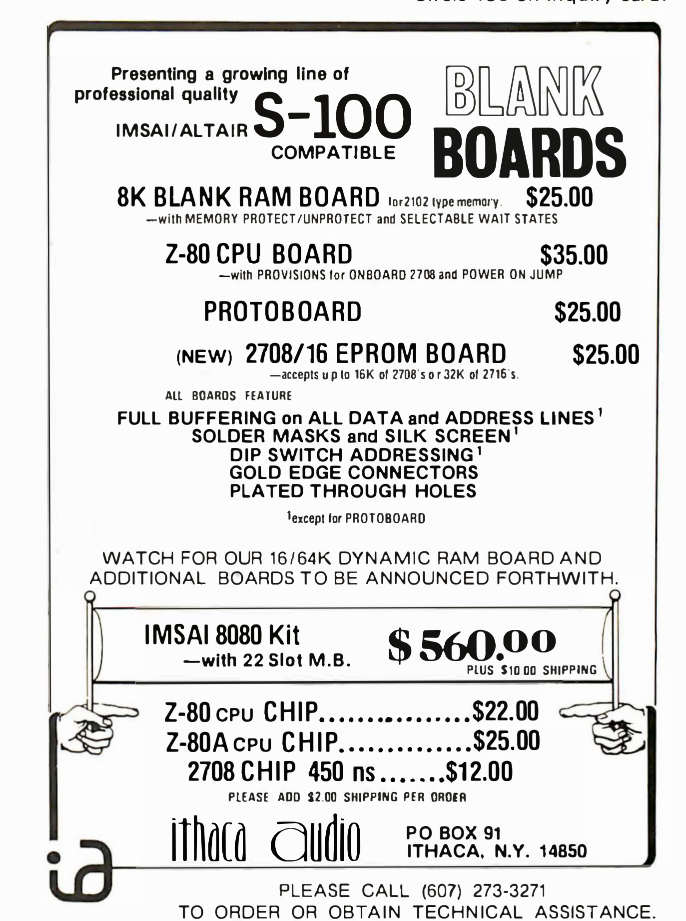
The interpreter is especially adapted to interactive programming. The language

presented here is tailored to structured programming techniques which can yield clear, precise code. Our implementation of the interpreter is written in a macrolanguage which may be adapted to any microprocessor by defining each macroinstruction in the assembly language of the microprocessor. A compiler for the same macrolanguage was also written so that a resident machine language version may be made when it is required.

The main features of this interpreter are: the structured language, the methods for evaluating expressions, and the methods for handling IO. Much of the detail in handling data is taken over by the interpreter so that only the fundamental considerations must be considered in writing a program.■

BIBLIOGRAPHY

1. Bloom, A M, "The ELSE must go to," *Datamation,* pages 123 to 128, May 1975.
2. Maurer, W D, "Processing Algebraic Expressions," BYTE, pages 26 to 30, February 1976.
3. Kerninghan and Plauger, *The Elements of Programming Style,* McGraw Hill, New York, 1974.



Larry Weinstein
Objective Design Inc
POB 20325
Tallahassee FL 32304

How To Get Your Tarbell Going

General Theory

The function of the Tarbell cassette interface (referred to as the "Tarbell") is to enable a computer system to save the contents of memory on audio tape. The purpose of this article is to explain how the Tarbell interface works and to suggest some improvements to its design for readers who have had difficulties with the unit.

The Tarbell is intended for use with inexpensive cassette recorders: the inputs and outputs are matched for the typical Aux In, Ext Spkr and Earphone connections. The computer interface to the Tarbell is on a byte level, with the bytes and commands passed by IO instructions on the Altair (S-100) bus.

Figure 1: Block diagram of the Tarbell cassette interface board.

The Tarbell converts digital information to an audio form that can be written on magnetic tape. In turn, it recovers the digital data from the audio signal. These are the primary functions; the rest have to do with the "housekeeping" involved with the Altair (S-100) interface.

Figure 1 shows a simplified block drawing of the Tarbell.

A cassette recorder has definite frequency limitations. The higher the frequency, the less accurate the signal reproduction will be. On the other hand, speed of operation is critical for the success of a storage medium. The Tarbell makes its compromise at approximately 1500 bps. This is determined by the interface clock.

The rate of data flow to the cassette must be known if the data is to be recovered. At first it might seem that we could use the same clock to move raw data to and from the tape. The problem is that a cumulative error will quickly build up when a long stream of data is read. There are two solutions to this. First, write the data only in small groups (say ten bits) with definite start and stop points in each group. This is called asynchronous recording. Second, write long uninterrupted data streams and include some clock information with the data. This is called synchronous recording.

The Tarbell generates synchronous data streams. Some clock information is added to the data by a technique known as phase encoding. To phase encode, one simply performs an exclusive OR operation with the clock and data (see figure 2). The Tarbell block diagram now takes on the form of figure 3.

Note that phase encoding does not mean that the decoding circuitry is free from the task of generating a matching clock. This will still be a critical part of the operation. We have simply eliminated the possibility of *cumulative* timing errors.

Assembly

The Tarbell cassette interface board is plated through but does not use a solder mask or silk screen printing. A 30 page manual is included with all needed parts. The kit does not include sockets for integrated circuits.

Assembly is not difficult. The original design lacked several pull up resistors and small capacitors, which led to noise problems. Subsequent revisions have incorporated these parts without any major board changes. Consequently, some of these parts are in unlikely places. A careful examination of the assembly drawing is required. If you have access to a copying machine, I suggest that you copy the parts list, assembly drawing, and two schematic pages to facilitate construction. Repeatedly flipping back and forth in the manual becomes tiring and one does not feel so bad about checking off items in pencil on a working copy as construction progresses.

There is a 50 k potentiometer on the board that is inappropriate. It is of the thumbwheel variety, and is too big: you cannot insert a board in the Altair bus slot directly in front of a Tarbell. There are also electronic problems with this part, which we will get to presently.

Operation (Digital Sections)

For output, bytes are loaded into a shift register. A timer clocks data out of the register into an exclusive OR gate. The same timing signal goes into the other input of the exclusive OR. The result is that a phase encoded signal is written onto the tape. A status bit informs the computer program that the last bit is being transmitted and the next byte can be loaded.

For input, the decoded clock signal feeds the data into a shift register. For startup, the register is examined for a sync byte. When this pattern is detected, a modulo 8 counter is enabled. This counter flags the computer program after eight new bits (byte) are loaded into the shift register. The sync byte pattern (hexadecimal E6, or binary 11100110) is hardwired into the interface.

A cassette with a sync stream written on it is supplied. An LED on the Tarbell is supposed to light up when the aforementioned sync code is detected. The setup operation consists of adjusting the cassette volume control and the 50 k pot until the LED remains on with a steady light. Here is where the difficulties begin.

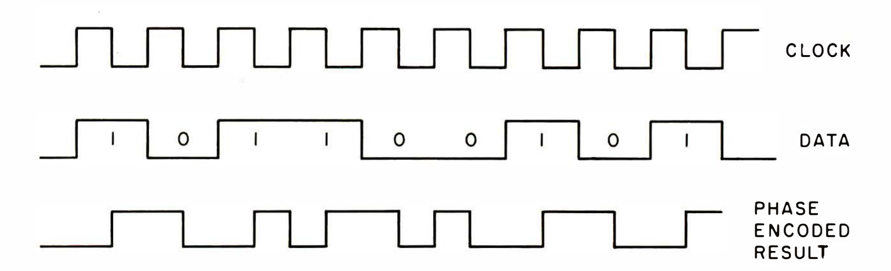


Figure 2: Phase encoding. The Tarbell interface uses this technique, which involves performing an exclusive OR operation with the clock and the data.

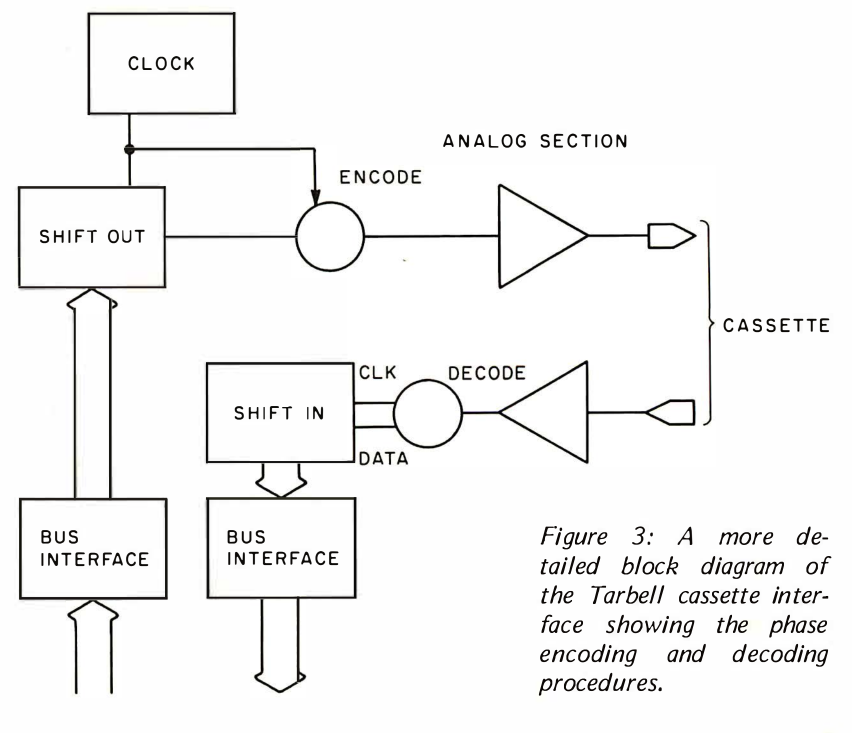


Figure 3: A more detailed block diagram of the Tarbell cassette interface showing the phase encoding and decoding procedures.

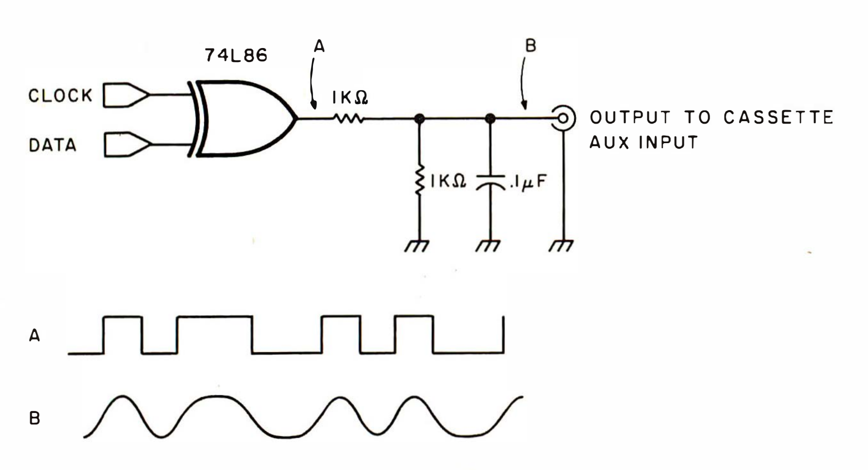


Figure 4: Output section of the Tarbell interface. The circuit contains a simple low pass filter with a cutoff frequency of 1.5 kHz. The filter eliminates the high order harmonics to produce an approximate sine wave, which is then recorded onto the cassette.

The presence of a steady sync light is a good indication, but it does not guarantee the ability to read long files. A single missed clock pulse in the sync stream will almost certainly go unnoticed. However, a single missed clock pulse during the reading of a data file will cause the subsequent bits to be read incorrectly. Also, the sync stream does not have a 010 pattern in it, which turns out to be a prime candidate for dropping a clock pulse.

With some cassette players and Tarbell combinations, the control settings are noncritical. The lack of a good setup indicator isn't important in these cases. On other cassette players the settings *are* critical; extremely so. Here, the absence of a source of feedback for the setup is sorely missed.

Our early experiences with the Tarbell were problematical. As we began to look

*ON SOME MODELS,THIS MAY BE A 2.4K RESISTOR

Figure 5: Input circuitry of the Tarbell cassette interface (internal details of the 8T20 circuit have been included for clarity). The incoming sine wave signal is transformed into a digital signal by the comparator circuit inside the 8T20 (see figure 6).

more closely at the device, we ran into more questions than answers. For example:

A. Why do different Tarbell units have different levels of reliability?
B. Why do seemingly equivalent tape decks yield different performances?
C. Why will a very cheap cassette machine outperform one costing many times more money?
D. Why do some very good cassette tape brands fail to do well with the Tarbell, while others, even less expensive ones, do a fine job?
E. Why must (as the manual recommends) the tone control be placed at maximum treble? With the highest frequency we wish to have on the tape being 1500 Hz, the results should be *better* with the tone control on a high bass setting.
F. How were the resistance and capacitance values in the analog sections chosen?

With these questions in mind, we took a closer look at the Tarbell and came up with the following information.

The critical part of any tape storage system is the analog input section. The entire digital data and clock recovery circuit of the Tarbell is constructed from a single IC (the 8T20) and a few passive components.

Figure 4 gives the output section. This is really a simple low pass filter with a cutoff frequency of 1.5 kHz. The filter eliminates the high order harmonics of the output digital signal. The result is a sine wave, or nearly so.

The input section of the Tarbell is shown in figure 5. We have drawn out the internal 8T20 circuitry. Data on the 8T20 in the early Tarbell manuals was absent.

To recover the data, it is first necessary to convert the sine wave recovered from the cassette unit to a digital signal. Assume for the moment that the sine wave is symmetric about 0 V. A comparator with one input grounded (a zero detect circuit) would then produce a digital signal that matches the original one (see figure 6).

Once the input signal passes through C6 (a 0.2 μF capacitor in the Tarbell input section), it loses any DC level. The DC level is then set by the 9 k and 5 k voltage divider resistors inside the 8T20. To convert the signal properly, the positive input of the 8T20 comparator must also be set to this voltage. This is accomplished by the voltage divider formed by R1 and R3. As figure 5 shows, R2 and diode CR1 play a part in this circuit by providing hysteresis: When the output of the comparator is high the divider circuit is electrically equivalent to figure 7a. When the output is low, the circuit is roughly equal to that of figure 7b. The effect of this is to eliminate oscillation about the bias point.

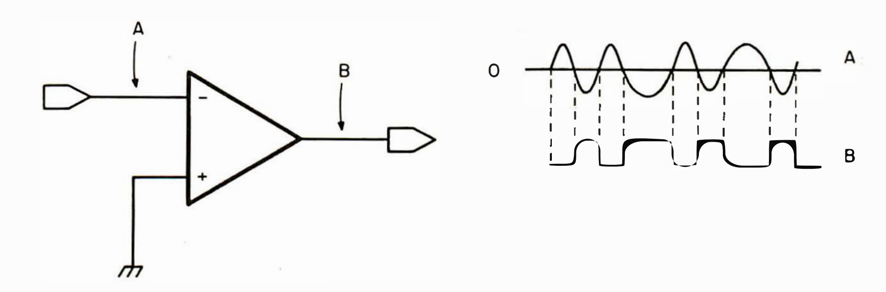


Figure 6: Action of the comparator inside the 8T20 circuit. The comparator acts as a zero crossover detector to transform the sinusoidal input from the cassette into a stream of digital pulses.

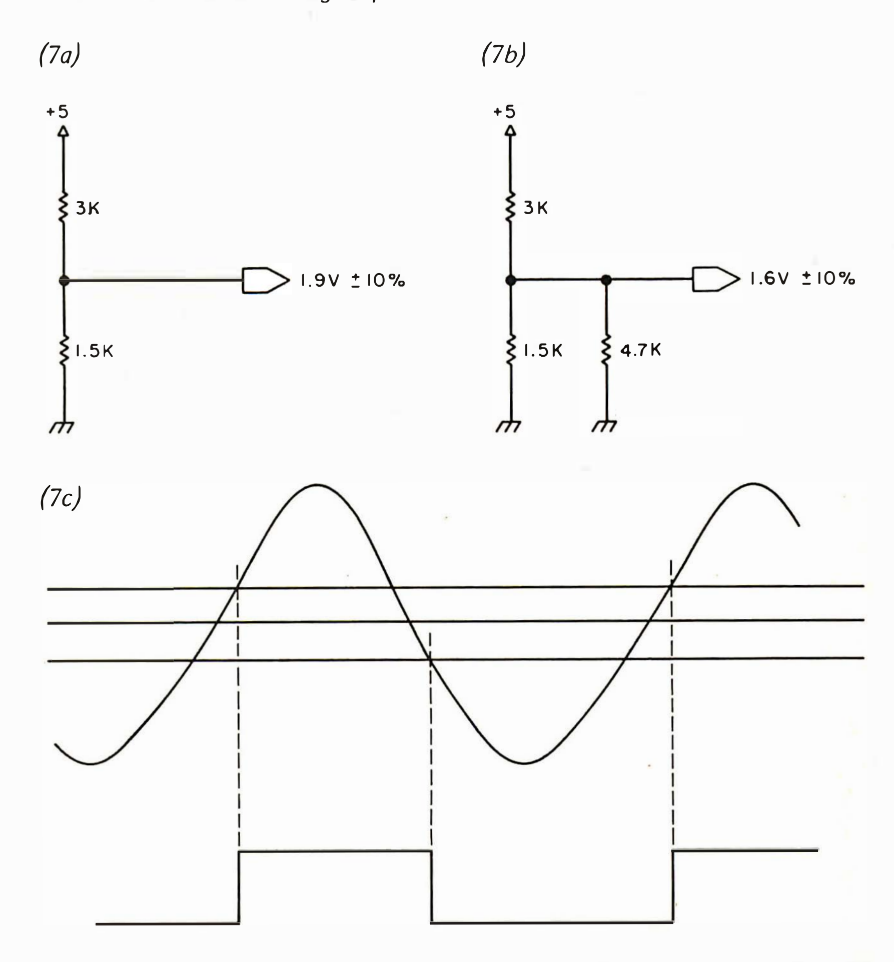


Figure 7: Equivalent circuits for the voltage divider input circuit (R1, R3, R2 and D1) in figure 5, plus the resulting output waveform. Figure 7a shows the equivalent circuit for the case when the comparator is high, and figure 7b shows the equivalent circuit when the comparator is low. Figure 7c is the output waveform. This hysteresis effect is designed to eliminate oscillation of the comparator if a signal "hovers" about the bias point.

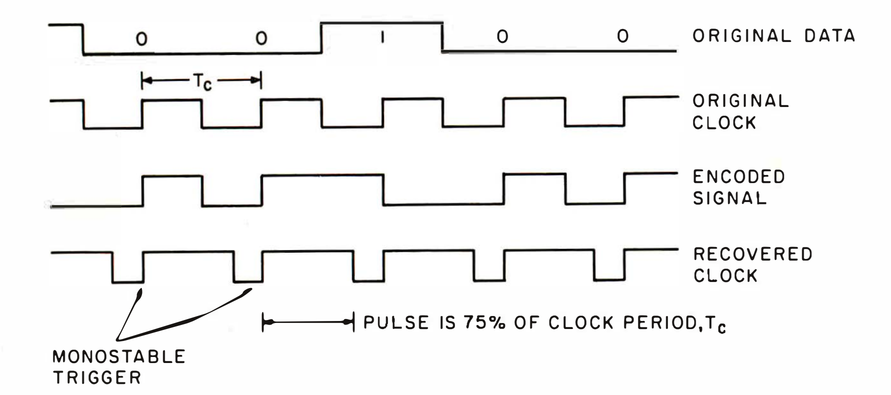


Figure 8: Recovery of the clock from the encoded signal. The encoded signal is formed by performing an exclusive OR operation on the data and the clock. To recover the clock, a one shot with a duration of exactly 0.75 clock cycles fires on every transition of the encoded signal.

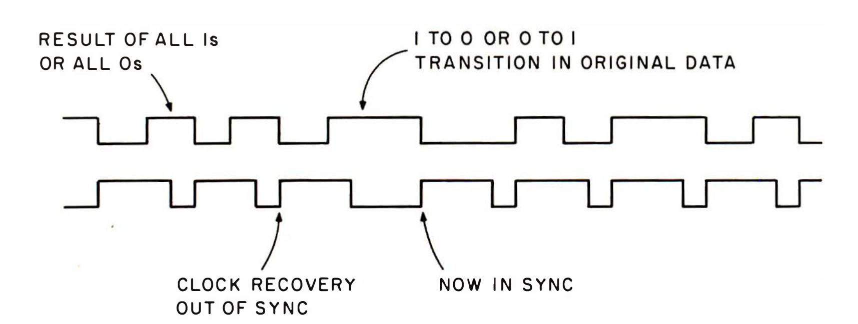


Figure 9: Automatic synchronization of the one shot (monostable) pulses and the signal transitions (see figure 8). As soon as a 1 to 0 or a 0 to 1 transition takes place in the data, the recovery one shot is forced to "fall in line."

Figure 10: Complete timing diagram for signal processing in the Tarbell interface.

HEXADECIMAL 22 E6H-SYNC BYTE

0 0 1 0 0 0 1 0 1 1 1 0 0 1 1 0

ORIGINAL DATA TO TARBELL

ORIGINAL CLOCK

PHASE ENCODED CLOCK AND DATA

ANALOG SIGNAL TO AND FROM CASSETTE ASSUMES "PERFECT" REPRODUCTION

DIGITAL SIGNAL RECOVERED FROM ANALOG

RECOVERED CLOCK-GENERATED BY MONOSTABLE

RECOVERED DATA-WHICH IS INVERTED

INVERT TO ORIGINAL DATA

DATA BECOMES VALID AFTER FIRST 0 TO 1 TRANSITION

(*) THIS LOW FREQUENCY WAVE WILL OFTEN BE LOW IN VOLUME AND DISTORTED, RESULTING IN A DROPPED CLOCK AND LOSS OF SYNCHRONIZATION

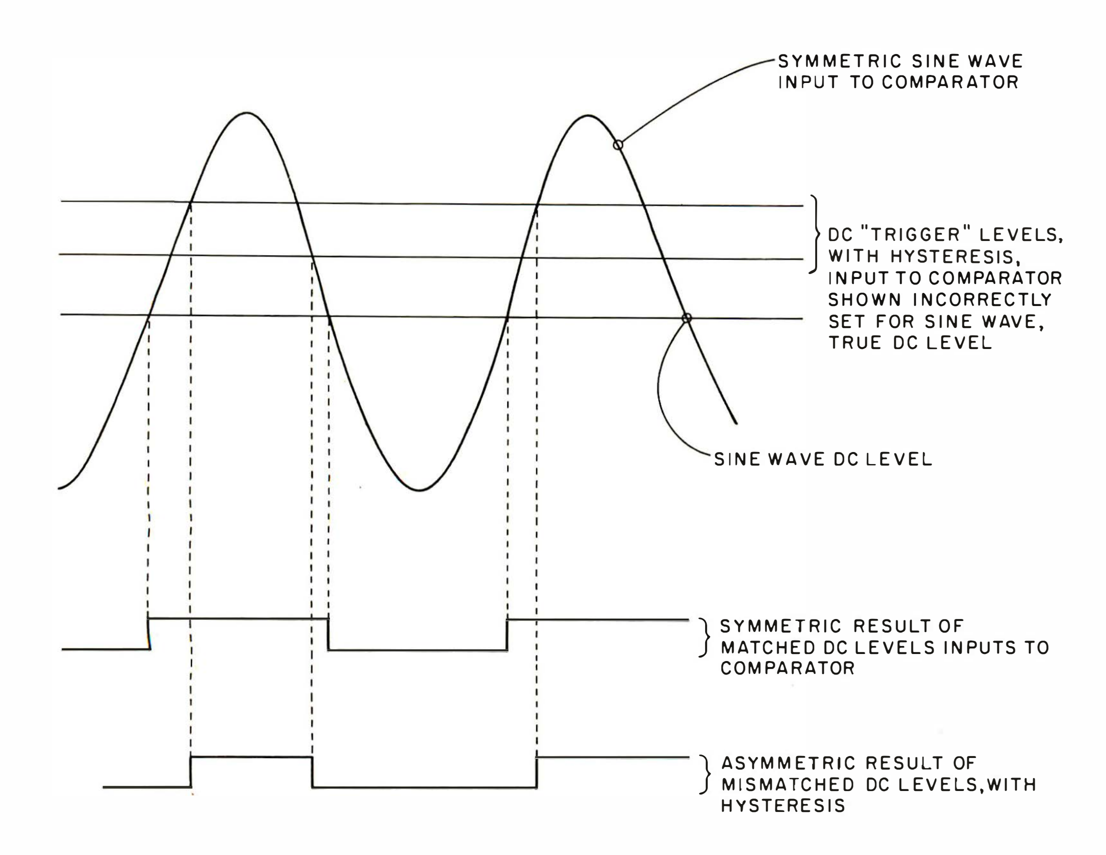


Figure 11: Effect of mismatched comparator input DC levels.

C16 reduces any very high frequency noise coming in on the line. C6, besides serving as a coupling capacitor, also forms a filter with the 8T20's internal 5 k resistor. The effect is to reduce the low frequency part of the signal. It is also an effective 60 Hz and "wow" filter.

Once the original digital signal has been recovered, we can proceed to reconstruct the clock signal, and from that, the data. On every transition of the digital signal, a monostable is triggered (see figure 8). The timing of the pulse is critical. It should be 75% of the period of the output clock. (You may have to study figure 8 carefully in order to understand how this recovery process works.)

Next, examine figure 9. It shows the automatic synchronization process of the monostable pulses and the signal transitions. As soon as a 1 to 0 or a 0 to 1 transition occurs in the original data, the recovery monostable is forced to "fall in line." For this reason, some kind of start byte is required ahead of the normal sync byte when using the Tarbell. The entire process is shown in figure 10.

The major problem with this circuit is its sensitivity to waveshape and amplitude. The primary cause of this rests in the way the DC levels are set for the comparator. The 8T20 specifications give the reference voltage available at pin 7 as a nominal 1.4 V, with minimum and maximum values of 0.8 and 2.0 V, respectively. Since the "+" input to the comparator is set by an independent voltage divider, an error of half a volt is possible. Figure 11 shows the effect of mismatched DC levels. As you can see, the more closely these DC levels are matched, the better off you will be.

The timing distortion produced by this effect can be compensated for by the proper setting of the monostable, up to a point. However, the more the timing is off, the more critical the pot setting will be.

The monostable pulse time is determined by C7 and R8, a 50 k pot. The timing is defined by the relation:

$$T_W = (C)\ (R)\ (\ln 2)$$

For the given Tarbell output frequency we require a pulse of (.67 ms) (0.75) = 0.5 ms. Therefore, the R/C relation is R= .72/C, with R in kilohms and C in microfarads. For a .033 μF capacitor, R should be 21.85 kΩ; for .039 μF, it should be 18.5 kΩ. A large fixed resistor in series with a 5 kΩ trimpot would do a far better job here.

The next factor affecting this timing is in the cassette transport itself. Flutter, a high frequency variation in tape speed, will cause the sine waves to vary in period. Figure 12a shows the effect of flutter.

The shape, symmetry, and amplitude of the wave will also affect this timing. Inexpensive tape machines generally use tone controls that work in tandem with the

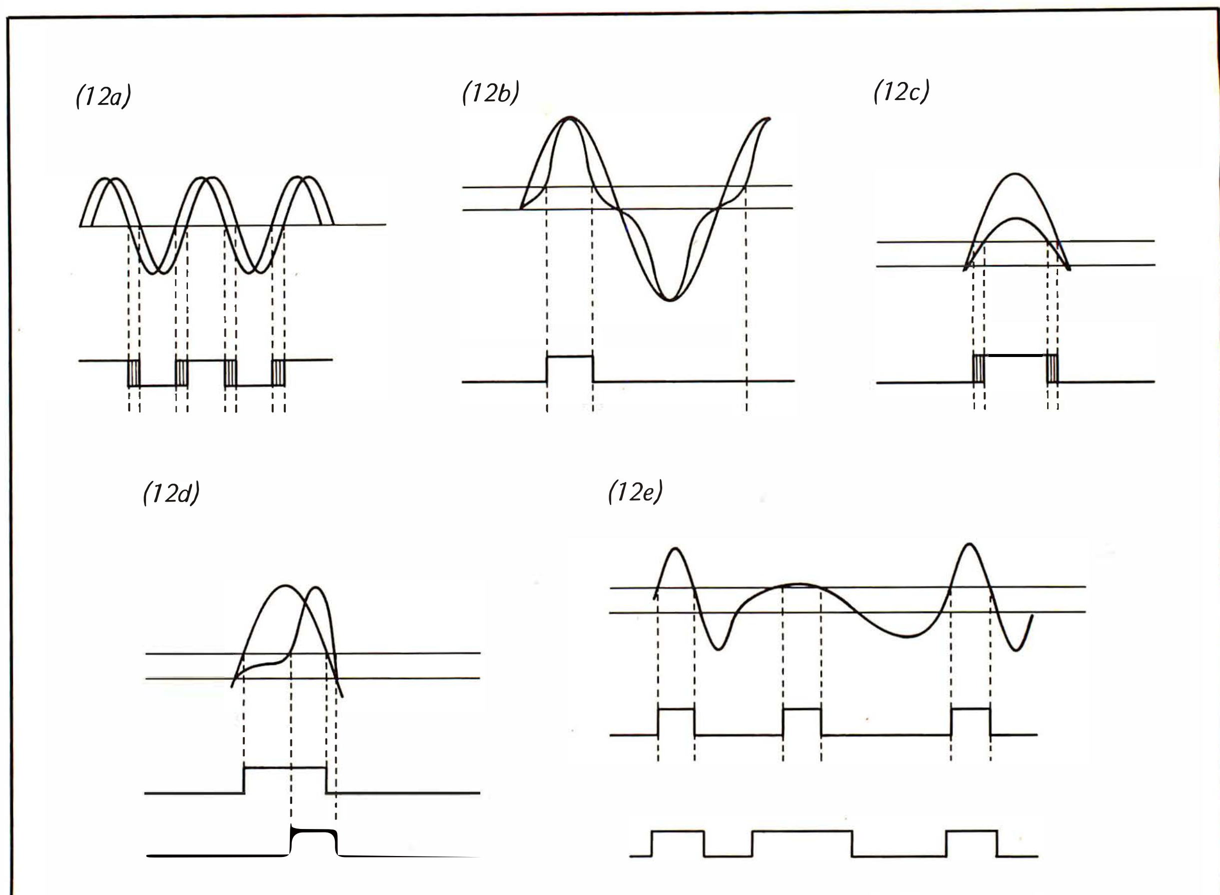


Figure 12: Factors causing timing distortion in Tarbell processed signals. Figure 12a shows the effects of flutter, or high frequency variations in tape speed. Figures 12a, 12b and 12c illustrate the effects of shape, symmetry and amplitude, respectively, of the signal waveform on the digitized output. Figure 12 shows how changes in signal amplitude caused by the low pass filter in the input circuit (see C6 in figure 5) can affect pulse width.

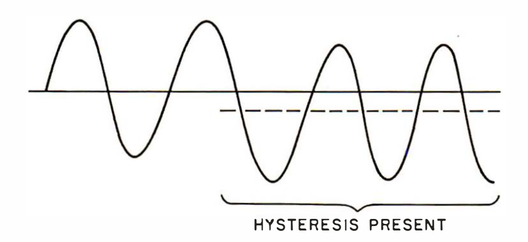


Figure 13: Effect of the presence of hysteresis: a sudden unexplained dip in DC level.

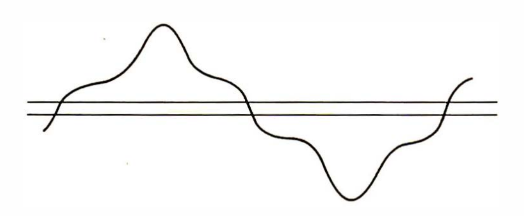


Figure 14: High amplitude signal with steep sides resulting from a high treble setting on the cassette recorder.

volume control. Each will affect the other. The effects of these factors are shown in figures 12b, c, and d.

The high pass filter created by C6 in the Tarbell causes the amplitude of the input signal to vary according to frequency. The result is shown in figure 12e. This frequency change area is already a sensitive point; the mismatch of amplitudes compounds matters.

We noticed one additional effect in a Tarbell unit, for which we have no explanation as yet. The input appears as in figure 13 whenever the hysteresis circuit is connected. With the hysteresis removed the wave oscillates about a fixed center line.

Bearing all of this in mind, we're ready to try for some answers.

Tarbell units with the more closely matched DC level inputs to their comparators will be less sensitive to all of the factors that can cause problems. A very slight difference, even 200 mV, is significant.

Also, the higher the input signal ampli-

tude, the less likely any of the waveshape factors are to have any effect.

Why do some Tarbell units work in the higher end of their volume range but not at the very top? This is due to the connection between the volume and tone controls. When the volume is at maximum, especially where the treble control is also at an extreme, the waveshape is severely distorted.

When the tone control is at maximum, the amplitude of the signal is increased and the waveshape is affected. The general outcome is a wave with steep sides about the "zero level" (see figure 14). The amplitude increase and steep sides tend to produce a more accurate digital signal.

A high bass setting reduces the amplitude of the wave with a greater effect on the higher frequency section. With some cassette players, a full bass setting can produce up to a 3 dB per octave loss beginning in the area of a few hundred Hz. It is the overall signal loss that makes a high bass tone setting unacceptable.

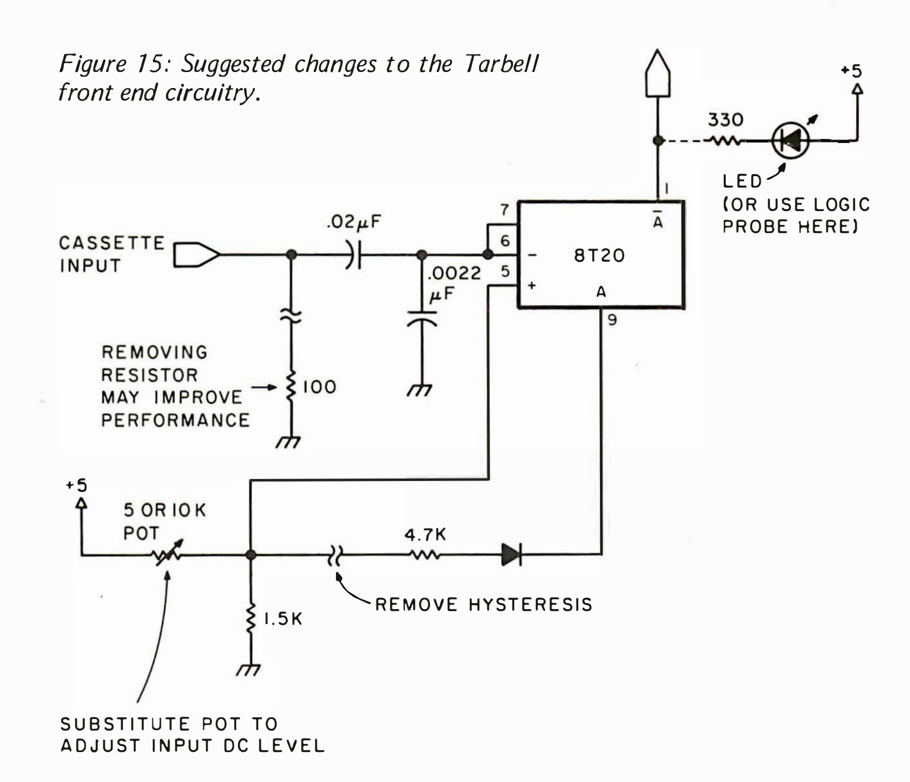


Figure 15: Suggested changes to the Tarbell front end circuitry.

The presence of even mild dropouts on the cassette tape will also cause problems. A 1 ms loss of a few decibels of output level wouldn't be noticed in audio work, but could mean the fatal dropping of a clock pulse when recording digital information. Thus, some cassette tapes that pass audio tests with flying colors may be unacceptable for digital applications. (We have had excellent results with Scotch low noise, high density C-60 tape.)

As for the differences in cassette decks, there are many possible factors: probably the main one is the amplitude of the output signal. However, the amplitude effect is closely tied to the waveshape, and a pure sinewave does not always yield the best results. In other words, high cost and accurate reproduction do not guarantee good performance.

Listing 1: The author's test tape for the Tarbell cassette interface.

```
0000                    CASC       EQU     6EH
0000                    CASD       EQU     6FH
0000                    *
0000                    * WRITE OUT STREAM OF ALTERNATING
0000                    * SYNC (E6H) BYTES AND TEST (22H) BYTES
0000                    *
0000 06 22              LOOPW      MVI     B,22H
0002 CD 0D 00                      CALL    SUB
0005 06 E6                         MVI     B,0E6H
0007 CD 0D 00                      CALL    SUB
000A C3 00 00                      JMP     LOOPW
000D                    *
000D                    * SUB WILL WRITE TO THE TARBELL
000D                    *
000D DB 6E              SUB        IN      CASC      * TEST STATUS
000F E6 20                         ANI     20H
0011 C2 0D 00                      JNZ     SUB
0014 78                            MOV     A,B
0015 D3 6E                         OUT     CASC      * OUTPUT BYTE
0017 C9                            RET
0018                    *
0018                    * TEST PROGRAM = THE TAPE GENERATED
0018                    * ABOVE IS PLAYED WHILE RUNNING THIS
0018                    * PROGRAM.  A SIGNAL (BELL, BEEP, OR
0018                    * LIGHT) IMPLIES AN ERROR DETECTED.
0018                    *
0018 3E 10              TEST       MVI     A,10H
001A D3 6E                         OUT     CASC      * RESET TARBELL
001C                    *
001C 06 22              LOOPR      MVI     B,22H
001E CD 32 00                      CALL    SUBR      * READ BYTE
0021 C2 2C 00                      JNZ     MISS      * NZ--NOT 22H, ERR
0024 06 E6                         MVI     B,0E6H    * 22H, CHECK SYNC
0026 CD 32 00                      CALL    SUBR
0029 CA 1C 00                      JZ      LOOPR     * SYNC OK, LOOP
002C                    *
002C                    * 22H MISSED, GIVE ERROR SIGNAL.
002C CD 3D 00           MISS       CALL    SIG       * USER SUPPLIED
002F                    *
002F C3 18 00                      JMP     TEST      * RESET, RESTART
0032                    *
0032 DB 6E              SUBR       IN      CASC
0034 E6 10                         ANI     10H       * BYTE READY?
0036 C2 32 00                      JNZ     SUBR
0039 DB 6F                         IN      CASD      * INPUT BYTE
003B B8                            CMP     B         * COMPARE
003C C9                            RET
003D                    *
003D                    SIG        DS      20D       * ADD SIGNAL HERE.
0051                    *
READY
CASC   006E     CASD   006F     LOOPW  0000     SUB    000D
TEST   0018     LOOPR  001C     MISS   002C     SUBR   0032
SIG    003D
```

Corrections

A few simple changes in the Tarbell input section will significantly improve performance. (Refer to figure 15.)

First, remove the hysteresis circuit, either by cutting the trace on the rear of the card that connects R2 to CR1, or by simply removing one of these two components. If you are a diehard believer in hysteresis, replace R2 with a 47 k or larger resistor. Bear in mind that the 8T20 specs give a ±4 mV input threshold.

Next, replace R1 with a 5 k or 10 k pot. This will enable you to set the "+" input level to match the signal DC level.

Set up the Tarbell with its cassette player. Place a logic probe on pin 1 or 9 of the 8T20 (or add a resistor and LED as in figure 15). With the cassette player off, adjust the R1 replacement pot near the area where the light switches from on to off.

Set the tone and volume controls to their halfway points. Use the program in listing 1 to generate a test tape. Note that a special test byte (hexadecimal 22, binary 00100010) alternates with sync.

Now play back the tape with the test program running. A signal (light, beep, etc) implies an error. First adjust the 50 k Tarbell pot. You should be able to get a steady sync light with few or no error signals. From there, adjust the volume and tone controls until you can run a long test without a single error signal. As with a well running Tarbell, you should have a large range of acceptable cassette settings.

Our experiences with Tarbells with these few changes have been excellent. They are totally reliable. Further, tapes written on other systems, can generally be read without readjusting the various control settings.

Conclusions

With revision D of the board, the noise prone floating inputs have been tied down (or up). But the input circuit is still lacking. The 8T20 internal bias resistors are clearly intended for use with a TTL input, not an analog one. The lack of adjustment on this bias will continue to cause problems, necessitating fixes such as the one given.

On the plus side, the Tarbell is a continually evolving and improving device. The responsiveness of its manufacturer (Don Tarbell) is unsurpassed in the industry.

The board is available, has no "exotic" components, and is simple to set up and use.

The cassette writing scheme which the Tarbell executes is one of several cassette methodologies now being used in the personal computing field. Several versions of this type of recording method are now available in the hobby market. The 1500 bps speed is acceptable for work with small to medium length data files. For program loading, it is excellent.

We'll take this opportunity to cast our vote for phase encoding at 800 bits per inch as a cassette standard and recommend it, from whatever manufacturer, for small computer systems.■

Manufacturer's Reply

Thanks for the opportunity to reply to Larry Weinstein's article.

First, to reply to the questions posed: A, B, C, and D are somewhat related. The main source of reliability problems we have found on the interface is faulty integrated circuits. These are sometimes difficult to isolate, especially when the problem is not occurring all the time. Tape drives vary considerably in their performance characteristics. The main requirements for our interface are a frequency response to 8000 Hz, and an output amplitude of at least 5 V peak to peak. We haven't found any recorders that have these characteristics that haven't worked with the interface. Some expensive recorders, sadly, don't have the above minimum requirements.

As mentioned in question E, the highest frequency the interface works with is apparently 1500 Hz. A certain number of harmonics above this, however, are required to accurately reproduce the phase shifts that this method uses. That's why it's usually better to have the tone set high. To answer question F, the parts values were generally first chosen by a combination of calculation and experience. They were then tuned empirically (ie: diddled on the breadboard) for optimum operation.

I don't think of C6 as a filter capacitor so much as I think of it as a differentiating capacitor. Its main purpose in my mind, in addition to removing the DC component, is to translate the peaks of the input waveform into zero crossings. In this way, the circuit becomes less dependent on input amplitude. Although the worst case tolerances of the components in the input section theoretically could *cause a problem, our experience is that they* don't. *Out of the many units that have been returned for repair,* none *required adjustment or replacement of these components to make them work. On the other hand, it is true that replacement of R1 with a potentiometer could mean the difference between operating or not operating with a marginal recorder. The reason that a pot was not used in the design is that I felt the fewer pots there were to adjust, the better off the user would be.*

We don't put a fixed resistor in series with the 50 k pot because we want to allow the user to adapt to much faster or slower speeds, as his requirement dictates. The reason for the hysteresis is to reduce the effects of noise on the input signal. With a sufficient amount of input amplitude, the percentage of distortion introduced by the hysteresis is minimal. Many computers have a fairly high level of noise, and so do many recorders. If you have a very clean system, you may not need the hysteresis, and can remove it as he suggests. This will also allow you to work with lower amplitudes, such as are generated by tape decks without amplifiers.

In spite of the above comments, I feel that Mr Weinstein's article is a valuable one, and is accurate, on the whole. His test program, especially, is excellent. I hope, however, that readers will not try the changes suggested in the article unless they actually are having problems. I would also like to take this opportunity to announce that the 90 day, no fault warranty on this product has now been extended to six months, and to encourage customers to send their boards back for a quick repair.

Donald E Tarbell
Tarbell Electronics
20620 S Leapwood Av, Suite P
Carson CA 90746

Event Queue

This month we begin a formal Event Queue, a calendar of coming events which we know about as of press time. In order to gain optimum coverage of your organization's meetings, computer conferences, seminars, workshops, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to:

Event Queue
BYTE magazine
70 Main St
Peterborough NH 03458

Each month we publish the current contents of the queue for the month of the cover date, and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

July 17-19, Data Processing Operations Management, Houston TX. This seminar will offer the senior data processing professional an opportunity to gather the latest management skills. The curriculum is designed toward practical, applied data processing management techniques. Contact Philip M Nowlen, Program Chairman, Director, Center for Continuing Education, University of Chicago, 1307 E 60th St, Chicago IL 60637.

July 17-21, Coding and Information Theory, UCLA, Los Angeles CA. This course will present the fundamentals of representation, storage and transmission of data. Protection against storage and transmission errors using error detection and error correcting (including hamming) codes will be developed. Efficiency enhancement through information compressing codes, predictive run encoding and Markov chains (probabilistic finite state machines) will be discussed. Contact Short Course Program Office, 6266 Boelter Hall, UCLA Extension, Los Angeles CA 90024, (213) 825-3344 or 825-1295.

July 25-26, Workshop on Use of Computers in Teaching Statistics, University of New Hampshire, Durham NH. Workshop participants will be scheduled for hands-on use of the following packages: Minitab II, IDA, SAS, SPSS and BMDP. Contact Dr Jerry Warren, Director, The Office of Academic Computing, 304 McConnell Hall, University of New Hampshire, Durham NH 03824.

July 26, Third Annual Indy Microcomputer Show, Holiday Inn, Indianapolis IN. There will be exhibits, demonstrations and technical seminars addressing the engineering, industrial, scientific, business and personal applications of microcomputer systems. Contact Thurman H Gladden, Naval Avionics Center, D-810, 600 E 21st St, Indianapolis IN 46218, (317) 353-3208.

July 31-August 4, Digital Filters, University of Toronto CANADA. This course will provide a practical introduction to the subject of digital filters. Topics will include the frequency approach, Fourier series and integrals, nonrecursive filter design, theory of recursive filter design, discrete Fourier transforms, fast Fourier transform implementation, estimation of power spectra and nonlinear phenomena due to quantizing signals. This course will be of interest to those who use linear combinations of data. The emphasis is on its basic nature and practicability. Contact Nonie Watanabe, Short Courses, 6266 Boelter Hall, UCLA Extension, Los Angeles CA 90024.

August 7-9, Third Jerusalem Conference on Information, Jerusalem ISRAEL. The conference will cover a broad range of topics on computing applications, science and technology. Primary emphasis will be on the role of computers in the transfer of technology between large and small countries. Contact Robert W Rector, Executive Director, AFIPS, 210 Summit Av, Montvale NJ 07645, (201) 391-9810.

August 7-9, Laser Beam Information Systems, Minneapolis MN. This seminar will cover the growing application of laser technology in image and data manipulation in the form of scanning, transmission, reproduction and control. The principles and practice of laser beam information systems will be covered in preparation for direct application to such fields as facsimile, computer memory and display, target identification, reconnaissance, photocomposition and image manipulation. Contact Philip M Nowlen, Program Chairman, Director, Center for Continuing Education, the University of Chicago, 1307 E 60th St, Chicago IL 60637.

August 7-11, Coding and Information Theory, University of Toronto CANADA. See July 17-21, UCLA, for information.

August 21-25, Digital Filters, UCLA. See July 31-August 4, University of Toronto, for information.

August 21-September 2, Courses on Microcomputer Interfacing and Analog Signal Conditioning, Virginia Polytechnic Institute and State University, Blacksburg VA 24060. The objective of these programs is to provide an educational experience for scientists, engineers, teachers, managers or technicians in the areas of microcomputer data acquisition, instrumentation, and measurement systems ranging from the analog sensor through the analog data channels to the microcomputer. The courses provide a combined lecture/ laboratory experience. Continuing education units are provided for each course. Contact Dr Linda Leffel, Center for Continuing Education, Virginia Polytechnic Institute and State University, Blacksburg VA 24061, (303) 951-5241.

August 24-27, PC '78, Philadelphia Civic Center, Philadelphia PA. The first day of PC '78 (August 24) will be an industry trade show which is open to dealers, the industry and exhibitors' guests. For the remaining three days the full Personal Computing Show and Personal Computing College will be running. Over 80 hours of free seminars are planned. Contact John H Dilks III, Rt 1, POB 242 (Warf Rd), Mays Landing NJ 08330.

August 29-31, Data Processing Operations Management, New York NY. See July 17-19, Houston TX, for information.

September 6-8, COMPCON Fall '78, Capitol Hilton Hotel, Washington DC. Sponsored by the IEEE Computer Society, this conference will cover computers and communications, interfaces and interactions. Such topics as microprocessors in communications, multiple computer systems, advances in communications technology and many others will be discussed at this conference. Contact Kenneth H Crandall Jr, COMPCON Fall '78, POB 639, Silver Spring MD 20901.

September 11-15, Coding and Information Theory, Georgia Institute of Technology, Atlanta GA. See July 17-21, UCLA, for information.

September 18-22, Digital Filters, Georgia Institute of Technology, Atlanta GA. See July 31-August 4, University of Toronto, for information.

September 29-October 1, International Microcomputer Exposition, Dallas Convention Center, Dallas TX. This exposition will be directed toward all levels of technology from the professional engineer to the beginning computer hobbyist. In addition to the seminars, a panel of experts will be available to answer questions. Contact Beverly Tanner at (214) 271-9311.■

Continued from page 63

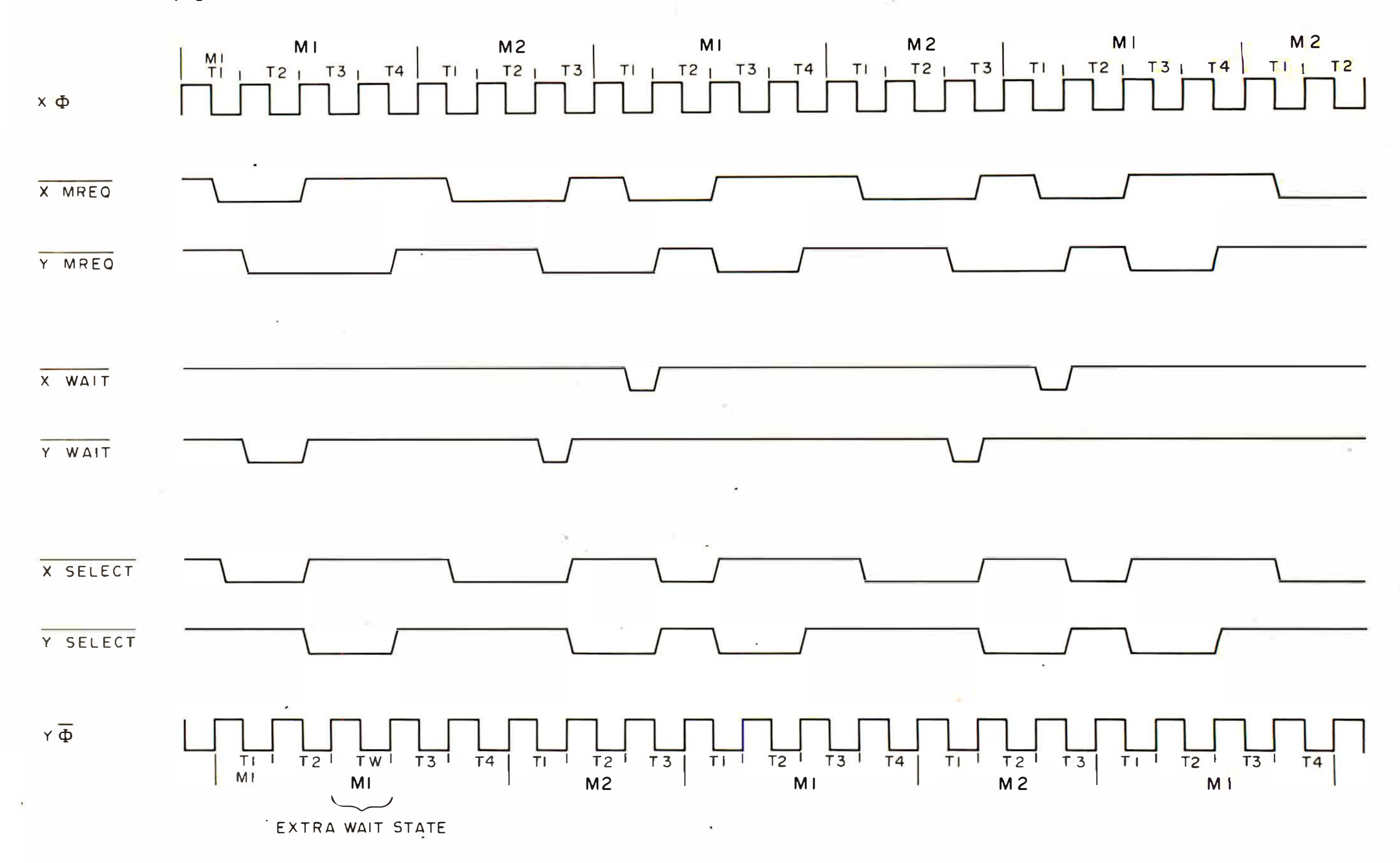


Figure 3b: M1,T1/M1,T1, one of the seven interprocessor T state alignments shown in table 1. Synchronization is achieved after three clock cycles in this example. A complete discussion of the M and T states can be found in the Z-80 technical manual. (Note that, even though the arbiter activates the wait lines at periods during synchronization, this has no effect on the processors because the lines are not sampled until the falling edge of T2.)

Inter-processor State Relationship P_X/P_Y	Synchronization Pattern M1,T1/M1,T3	M1,T1/M2,T3	Wait States P_X	P_Y	T States Until Synchronization
M1,T1/M1,T1		√	0	1	3
M1,T1/M1,T2	√		1	0	3
M1,T1/M1,T3	√		0	0	0
M1,T1/M1,T4	√		0	1	6
M1,T1/M2,T1	√		0	2	7
M1,T1/M2,T2		√	1	0	3
M1,T1/M2,T3		√	0	0	0

Table 3: Timing analysis for two Z-80 processors in parallel. The seven possible interprocessor state relationships are shown at left. The center column lists the two possible classes of operation for the parallel processors: the first (M1,T1/M1,T3) occurs when both processors are performing an op code fetch at the time of synchronization; the second is the case when one processor is performing an op code fetch while the other is performing a memory read or write. The wait states column indicates how many wait states each processor must undergo until synchronization occurs. Note that in two of the cases, the shared memory arbiter (see figure 2a) need not be employed, since the two processors fall into synchronization spontaneously.

suit, enabling IC3b; ie: granting processor Y's request.

System Timing

In order to choose a memory that is subject to overlapping access requests from more than one processor, system timing must be carefully examined. Important considerations in this design include the control logic propagation delay and the "window size" provided by the processors for read or write accesses to the common memory.

In the single processor system, the smallest memory access window of any Z-80 instruction occurs during the op code fetch cycle. The effective length of that cycle is a few nanoseconds less than 1.5 clock cycles (1.5 Φ). However, the dual processor configuration reduces the window size for two reasons: (1) the delay in processor selection (ie: the data gating signal) incurred by the control logic and, (2) the overlap of the memory request signals from opposing processors that is required to permit full speed operation by the processors. Further, the memory cycle time requirement becomes more stringent, accommodating from more than two clock cycles in a 1 processor system to less than one clock cycle in this system.

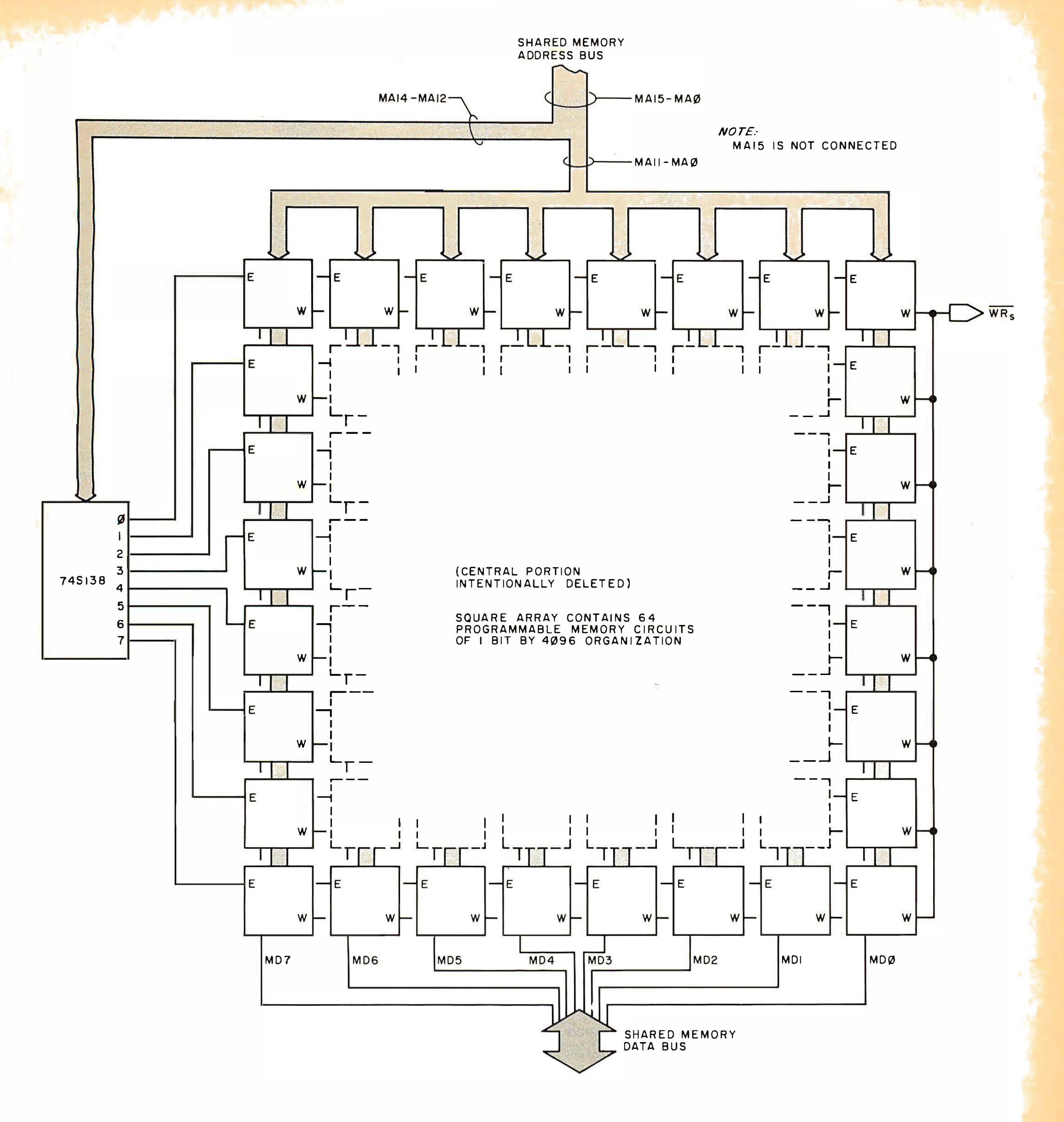


Figure 4: Block diagram of the shared memory. The memory is arranged in a square array of 64 static programmable memory integrated circuits with 4096 bits per circuit.

The clock that drives the processors operates at 2.5 MHz, defining a basic cycle time of 400 ns. With this information it is now possible to calculate the operating characteristics required of the shared memory.

As stated earlier, the memory access window depends on the control logic switching delay and the request signals overlap. It has been shown (see figure 3) that the smallest window occurs at times of bus request conflicts, and that this window has a length of one clock cycle. The equation, then, for actual window length is:

$$L_a = \Phi - \delta - T_c - T_d$$

where:

Φ = 400 ns (1 clock cycle)

δ = maximum delay in falling edge of $\overline{\text{MREQ}}$

T_c = maximum propagation delay of control logic

T_d = maximum propagation delay of decoding logic

Examining the control logic timing shown in table 2, we observe that the maximum timing delays from either $\overline{MREQ}$ line going active until the arbiter sets the corresponding $\overline{SELECT}$ line active are as follows:

IC In Signal Path	Maximum Propagation Delay (ns)
74S04	5
74S10	5
74LS126	+18
Total Arbiter Delay:	28 ns

Substituting into the equation for L_a, we obtain:

$$\begin{aligned} L_a &= \Phi - \delta - T_c - T_d \\ &= 400 - 20 - 28 - T_d \\ &= 352 - T_d \text{ ns} \end{aligned}$$

The switching delay of the decoding logic, T_d ($\overline{SELECT}$ active until the memory receives the signals), further reduces the memory access window. Referring to figures 2b and 4, the signal path T_d is:

$$\begin{aligned} T_d &= 7408 + \max[74S157 \text{ (select)}, 74S157 \text{ (enable)}] + 74S138 \\ &= 19 + \max[15, 11] + 12 \\ &= 46 \text{ ns} \end{aligned}$$

Finally,

$$\begin{aligned} L_a &= 352 - T_d \\ &= 306 \text{ ns} \end{aligned}$$

This allows plenty of time for a memory access operation; so much time, in fact, that we do not need the faster and more expensive bipolar programmable memory.

We must also consider the memory cycle timing (L_c), reduced by this two processor system to $\Phi - \delta$:

$$\begin{aligned} L_c &= \Phi - \delta \\ &= 400 - 20 \\ &= 380 \text{ ns} \end{aligned}$$

It is good design practice to calculate delays in the system using the maximum time figures rather than typical ones, and to adjust the results by including a safety margin. Accordingly, we specify the following requirements for the shared static programmable memory:

- Access time 280 ns or less
- Cycle time 350 ns or less

Conclusions and Possible Applications

The principle advantage of two (or more) parallel processors performing complementary tasks is the cost savings. For example, let us say that we operate a packet switching network in which multiple microprocessors perform the relay functions of each node, such as the TELENET of Telenet Communications Corporation. Our responsibilities include insuring data reliability (eg: using cyclic redundance coding (CRC), checksum, etc), doing format checks, and recognizing the destination of the traffic and routing it to another node in the network. Further, this service must be provided at high speed.

Clearly, for one processor to perform these and other nodal functions without some delay, high performance and high cost systems would be required. Conversely, multiple microprocessors could perform all of these tasks in parallel at a significant reduction in cost.

For the experimenter, a multiprocessor system doesn't appear to offer much beyond an interesting diversion in design engineering. As mentioned earlier, the benefit from this type of design is increased throughput (by virtue of the reduced per unit cost). This is an idea that has little significance for persons with a dedicated system.

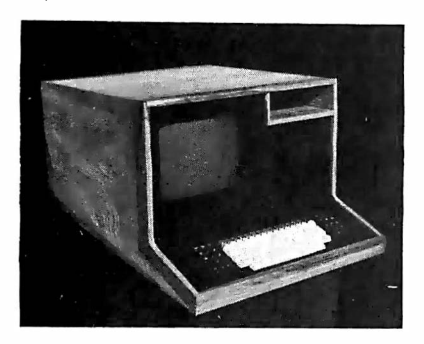
One possible application does come to mind, however. Many 8080 system owners are upgrading to the Z-80 for the expanded instruction set, but for some, direct replacement of a processor board is not possible. Why not consider adding a Z-80 with your current system acting as a front end? Admittedly, it seems like a bit of overkill, but it is an inexpensive way ($8 for the interface circuitry of this design) to upgrade. Of course, after installing another processor, the owner must write an operating system to accommodate the addition; but that's part of the continuing challenge to be found in the world of microprocessors.■

REFERENCES

Z80-CPU Technical Manual, Zilog, 170 State St, Los Altos CA 94022, 1976.

What's New?

85/P = 8085 + PASCAL



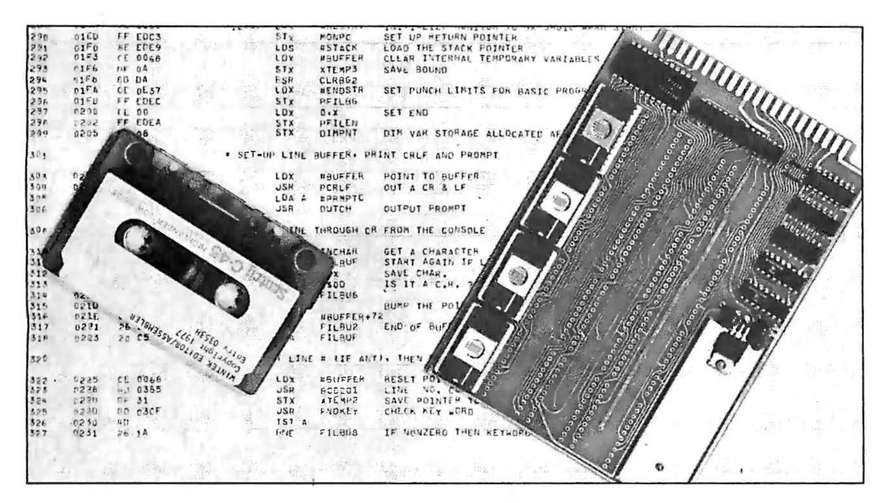
The new 85/P programmer's workbench from Northwest Microcomputer Systems Inc combines the throughput of the 3 MHz Intel 8085A and the power of PASCAL.

Designed for the serious applications programmer, the system features include: 8085A processor, a PASCAL compiler and interpreter, CP/M supporting BASIC, COBOL and FORTRAN, direct memory access, two Shugart floppy disk drives with 1 M bytes of online storage, 54 K bytes of 450 ns user available static programmable memory, a Hall effect keyboard with 103 keys, two serial ports (RS232C), two parallel ports (16 bits), and a 24 by 80 character 12 inch (30.5 cm) video display, all enclosed in a single cabinet.

The system provides the full PASCAL environment including a 725 line per minute compiler and interpreter, random and sequential files, a screen oriented editor, interactive source linked debugger, plus full documentation and a 90 day warranty. Pricing for the complete system is $7495. A variety of other packages are available, including a screen oriented accounting package and a word processor, from Northwest Microcomputer Systems Inc, 121 E 11th, Eugene OR 97401.■

Circle 602 on inquiry card.

New 6800 Industrial BASIC



Wintek 4 K BASIC is a 6800 BASIC interpreter optimized for industrial applications. Features of the package include control of interrupts, direct memory read and write, assembly language subroutine capability and flexible IO. The package is oriented toward process control and monitoring. 4 K BASIC retains all the advantages of an interactive high level language, including rapid coding and debugging, easy maintenance, and advanced control structures.

The interpreter may reside in programmable memory or in programmable read only memory for instant power on operation. If the BASIC program is also stored in programmable read only memory, the interpreter will immediately enter the RUN mode, allowing unattended operation in dedicated applications.

4 K BASIC is available on cassette at $95 or in programmable read only memory on a Wince read only memory module for $299. The source listing is available for $95. For further information contact Wintek Corp, 902 N Ninth St, Lafayette IN 47904.■

Circle 603 on inquiry card.

New 2708 Erasable Read Only Memory Programmer



A new 2708 erasable read only memory programmer has been announced by Smoke Signal Broadcasting, POB 2017, Hollywood CA 90028. Designated the POP-1, the unit lists for $149 and is designed to interface to the company's P-38-1 and P-38-FF erasable read only memory boards, which are SwTPC SS-50 bus compatible products. Complete software is provided on audio cassette. An adaptive programming technique is used that allows most 2708s to be programmed in 15 seconds. A separate self-contained power supply is used for the programming voltage insuring sufficient current capability to program erasable read only memory from any manufacturer.■

Circle 601 on inquiry card.

Text Processing System for Microcomputers

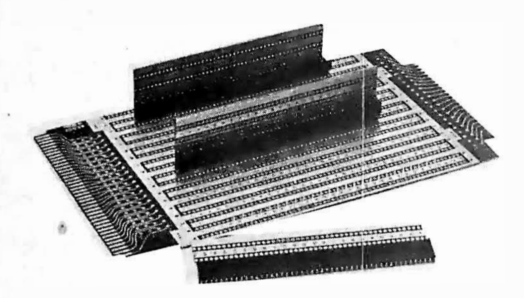
The Diaspar Text System is said to be a package of four programs which form a commercial text processing system. Text files are stored on diskettes using a named file structure with passwords. According to the vendor, hardware needed for this product is an 8080 based microcomputer with 32 K of main memory, a screen terminal, floppy disk and a printing terminal. Software required is the CP/M operating system and CBASIC runtime package. The system comes on standard diskettes with a user's manual for $195 from Diaspar Data Systems, POB 888, San Juan Capistrano CA 92675.■

Circle 604 on inquiry card.

What's New?

of INTEREST to DESIGNERS

Keeping Connected



The new 2505 MODCON series is available in double row configurations of 10, 20, 40, 60, 80 and 100. These modular high density receptacle connectors are designed for board to board interconnect applications. The connectors are easy to mount using box form contacts that mate with conventional 0.025 by 0.025 wiring posts on 100 inch center to center spacing. The series operates in temperatures between −55 to +150° C. Operating voltage is 800 VDC at sea level; insulation resistance is 5000 M Ω minimum at 500 VDC; current rating is maximum 3 A; and contact resistance is 10 mΩ at 3 A. Contact Stanford Applied Engineering, 340 Martin Av, Santa Clara CA 95050.■

Circle 629 on inquiry card.

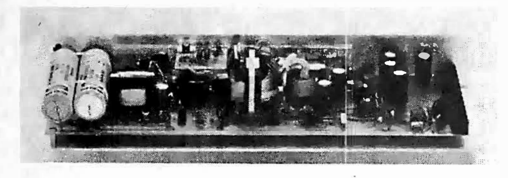
New Probe Extends AQ6800 Microprocessor Analyzer to 6802 Use



This buffered probe extends the capabilities of the AQ6800 Microprocessor Analyzer to 6802 microprocessors. With the PRB68/02 probe, the AQ6800 displays all address, data and status information of any 6802 microcomputer system, and provides direct user interaction with all memory locations, IO ports, and internal microprocessor registers. The probe clips directly to the 6802 microprocessor chip in the system being tested. Interactive features include the ability to examine or modify the contents of all 6800 or 6802 internal registers, plus the program counter, manual or breakpoint program halt, single step operation, execution of single byte instructions independent of normal program flow and many other control capabilities. The probe is priced at $295 and the AQ6800/02 system, complete with probe, is $1950. Contact AQ Systems Inc, 1736 Front St, Yorktown Heights NY 10598.■

Circle 630 on inquiry card.

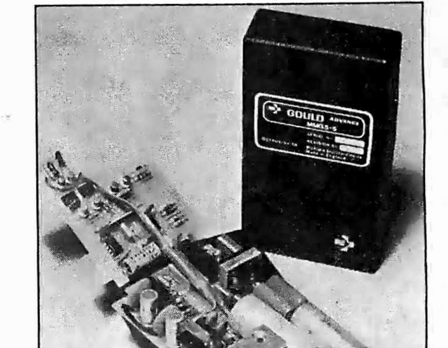
200 and 400 W Open Frame Switching Regulated Power Supplies



The OL-200 is a four output unit which supplies 200 W of continuous power, +5 V at 25 A (maximum) from one output, −5 V at 4 A, and ±12 V at 4 A each. The OL-400 is a five output unit that is capable of supplying a continuous 400 W, ±5 V at 45 A from one output, ±12 V at 10 A each from two outputs, and −5 V and +24 V at 4 A each from the remaining two outputs. Each unit is capable under transient conditions of handling three times the rated current. Both units can be adapted to provide voltages specified within ±70 V and up to 4 A per output for the OL-200 and 10 A per output for the OL-400. Input voltages are also user selectable. Both units will operate from either 115 VAC or 230 VAC and are equipped with brownout protection that allows them to operate without performance degradation at line voltages as low as 95 VAC (115 V option) or 190 VAC (230 V option). Both power supplies can provide 16 ms of continuous power after full loss of input. Standard features include an input EMI filter, a series thermistor that reduces input line surges at turn on, reverse voltage protection, and protection against system shorts. The OL-200 is priced at $248 and the OL-400 at $395 in quantities of 100. Contact Boschert Associates, 384 Santa Trinita, Sunnyvale CA 94086.■

Circle 631 on inquiry card.

Miniature Switching Power Supplies



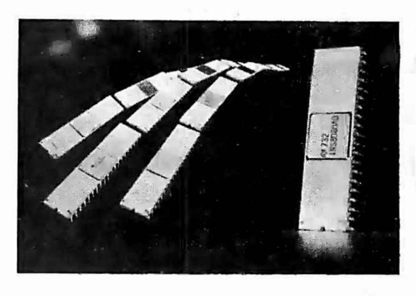
Three 12 V, 15 V and 24 V units, with efficiencies from 75 to 85 percent, have been added to Gould's MMG line of 5 V, 25 W switching power supplies. The new units operate from 110 and 120 V or 220 and 240 V ±10%, 50 or 60 Hz, and currents from 1.4 to 2.5 A. Optical coupling is used to provide 4 kV rms insulation (5.7 kV peak) between input and output. Units can be used in series or parallel operation without special interconnections.

Remote sensing is available from terminals on the printed circuit board adjacent to the output connections for control of voltage at the load instead of at the power supply. Standard features include overcurrent and overvoltage protection. Gould MMG switching power supplies carry a 5 year warranty.

The units cost $135 in quantities of one to nine. Contact Gould's Electronic Components Division, 4601 N Arden Dr, El Monte CA 91731.■

Circle 632 on inquiry card.

It's Late in the Learning Curve for 8080s



National Semiconductor Corporation has announced across the board price reductions for its version of 8080A microprocessors. The price of National's plastic package INS8080AN is now listed at $9.98 in quantities of 1 to 24, reduced from a previous listing of $15.50 each. In quantities above 100, the device has been marked down by one third, from $10.80 to $7.10, as quoted in National's latest OEM price list. Contact National Semiconductor Corp, 2900 Semiconductor Dr, Santa Clara CA 95051.■

Circle 633 on inquiry card.

JADE

FOR ALL CUSTOMERS EXCEPT CALIF. CALL TOLL FREE 800-421-5809

21L02 (450ns) Static Rams 100 @ $1.10 ea.	1702A E—PROM 8 @ $3.75 ea.	6502 Microprocessor 5 @ $11.00 ea.	2708 (450ns) E—PROM 8 @ $11.00 ea.	21L02 (250ns) Static Rams 100 @ $1.36 ea.	Z—80A Microprocessor 5 @ $25.00 ea.	8212 8 Bit I/O Port 25 @ $3.00 ea.	4116 (200ns) 16K Dyn. Ram 16 @ $24.00 ea.
Z-80 Microprocessor 5 @ $20.00 ea.	8224-4 Clk.Gen.&Dvr. 25 @ $8.75ea.	410D (200ns) Static Ram 100 @ $8.75ea.	4096 Dynamic Ram 100 @ $3.50 ea.	4200A (200ns) Static Rams 25 @ $10.00 ea.	74LS367 Hex Buffer 100 @ .70¢ ea.	74LS368 Hex Inverter 100 @ .70¢ ea.	2513 (5v) Character Gen. 5 @ $9.00 ea.

MICROCOMPUTER COMPONENTS

MICROPROCESSOR'S

F8	16.95
Z80	22.00
Z80A	28.00
CDP1802CD	19.95
2650	24.95
AM2901	22.95
6502	11.95
6800	18.95
6802	25.00
8008-1	9.95
8035	22.00
8080A	11.95
8085	27.00
TMS9900TL	75.00

8080A SUPPORT DEVICES

8212	3.50
8214	9.00
8216	3.75
8224	3.50
8224-4	9.95
8226	3.95
8228	7.95
8238	7.50
8251	9.95
8253	21.95
8255	21.95
8257	21.95
8259	21.95
8275	75.00
8279	20.00

FLOPPY OISC CONTROLLER

1771B	55.95
1771B-01	57.95

KEYBOARD CHIPS

AY5—2376	13.75
AY5—3600	13.75

PROM'S

1702A	4.00
2704	15.00
2708	12.00
2716	30.00
2716 Intl	38.00
2758	26.60
D3601	4.50
D3604	13.00
5203AQ	5.00
5204AQ	7.50
6834	17.50
6834-1	14.95
82S23B	4.00
82S129B	4.25
8223B	3.50

6800 SUPPORT

6810P	4.95
68B10P	6.00
6820P	7.50
6821P	7.50
6828P	11.25
6834P	16.95
6850P	9.75
6852P	11.75
6860P	10.00
6862P	14.50
6871P	28.00
6875P	8.75
6880P	2.50

Z80 SUPPORT DEVICES

3881	12.95
3882	12.95

STATIC RAMS

21L02	1.50	1.24	1.18
21L02 (350)	1.60	1.35	1.25
21L02 (250)	1.75	1.60	1.50
410D	10.75	10.00	9.25
1101A	1.00	.90	.80
2101-1	2.95	2.75	2.60
2102	1.25	1.15	1.00
2111-1	3.95	3.50	3.25
2112-1	2.95	2.80	2.69
2114-3	11.00	10.00	9.25
2125L	11.10	9.00	8.30
2147	37.50		
31L01	2.50	2.35	2.00
3106	3.95	3.70	3.25
3107	3.95	3.70	3.25
TMS-4044	9.95	9.00	8.95
4200A	12.95		
TMS-4045	11.00	10.00	9.25
5101	8.30	7.40	7.25
74C89	3.25	3.05	2.85
7489	2.25	2.10	1.90
74S201	4.50	4.00	3.75
P8101	4.20	3.40	2.80
P8155	17.00	14.00	
P8156	21.00	18.00	
8599	1.88	1.75	1.60
9102BPC	1.65	1.45	1.30

CHARACTER GENERATORS

2513	6.75
2513 5v upper	9.75
2513 5v lower	10.95
2516	10.95
MCM6571	10.95
MCM6571A	10.95
MCM6574	13.25
MCM6575	13.25

WAVEFORM GENERATOR

8038	3.50
MC4024	2.25
566	1.50

DYNAMIC RAMS

416D/4116	32.00
1103	1.00
2104	4.00
2107B	4.25
2107B-4	3.95
TMS4050	4.00
TMS4060	4.50
TMS4070-2	32.00
4096	4.00
4116/416D	32.00
MM5270	4.50
MCM6605	5.00

USRT

S2350	10.75

UART'S

AY5-1013A	5.25
AY5-1014A	8.25
TR1602B	5.25
TMS6011	5.95
IM6402	10.80
IM6403	10.80

MISC. OTHER COMPONENTS

N8T20	3.39
N8T26	2.10
N8T95	1.35
N8T96	1.35
N8T97	1.35
N8T98	1.35
81LS95	2.00
81LS97	2.00
1488	1.75
1489	1.75
D3205	4.00
D3207A	4.55
D3208A	14.20
D3211	10.00
B3222	9.75
B3242	10.15
D3245	5.60
C3404	6.75
P3408A	12.00
P4201A	5.20
MM5320	7.50
MM5369	1.90
TMS5501	24.95
DM8130	2.90
DM8131	2.75
DM8833	2.50
DM8835	2.50
DM8837	1.75
MK50240	20.00
MK50250	15.00

JADE 8080A KIT

$100.00 KIT

BARE BOARD $30.00

E—PROM BOARDS

MR 8 (8K uses 2708) with 1K RAM	KIT	$99 50
MR 16T (16K uses 2716) with 1K RAM	KIT	$9950
MM 16 (16K uses 2708)		$9900
RAM/N/ROM (16K uses any E PROM)	KIT	$117 00
JG 8.16 (uses 2708 or 2716)	KIT	$59 95
BARE BOARD		$3000

TU-1

Convert T.V. set to Video Monitor.

KIT $8.95

STATIC RAM BOARDS

8K

250ns ASSEMBLED & TESTED	$189.95
450ns ASSEMBLED & TESTED	$149.75
250ns KIT	$169.95
450ns KIT	$125.00
BARE BOARD	25.00
6800 ADAPTER to S-100 System KIT	$12.95

16K

250ns ASSEMBLED & TESTED	$435.00
450ns ASSEMBLED & TESTED	$380.00
450ns KIT	$335.00

32K

250ns ASSEMBLED & TESTED	$850.00
450ns ASSEMBLED & TESTED	$775.00
450ns KIT	$675.00

DYNAMIC RAM BOARDS

On board Refresh power is provided with no wait states or cycle stealing required
+8VDC 400MA DC, +18VDC 400MA DC and -18VDC 30MA DC.

EXPANDABLE 32K

8K (375ns)	KIT	$151.00
16K (375ns)	KIT	$259.00
24K (375ns)	KIT	$367.00
32K (375ns)	KIT	$425.00

EXPANDABLE 64K

16K (375ns)	KIT	$281.00
32K (375ns)	KIT	$519.00
48K (375ns)	KIT	$757.00
64K (375ns)	KIT	$995.00

MOTHER BOARD's — S-100 Style

13 slot — w/front panel slot

BARE BOARD	$35.00
KIT	$95.00
22 slot ASSEMBLED & TESTED	$149.95

THE PROM SETTER

WRITE & READ
EPROM
1702A – 2708 – 2716
5204 – 6834

- Plugs directly into your ALTAIR IMSAI Computer
- Includes Main Module Board and External EPROM Socket Unit
- The EPROM Socket Unit is connected to the Computer through a 25 pin connector
- Programming is accomplished by the Computer
- Just read in the Program to be Written on the EPROM into your Processor and let the Computer do the rest
- Use Socket Unit to Read EPROM's Contents into your Computer
- Software included
- No external power supplies. Your computer does it all
- Doubles as an Eight Bit Parallel I/O
- Manual included

KIT $210.00

ASSEMBLED $375.00

KIM—1

ASSEMBLED & TESTED $245.00

MEMORY PLUS

for KIM—1
8K RAM (21L02)
8K EPROM
ASSEMBLED & TESTED
$245.00

JADE Z80 KIT

—with PROVISIONS for ONBOARD 2708 and POWER ON JUMP

$135.00 EA. (2MHZ)

$149.95 EA. (4MHZ)

BARE BOARD $35.00

JADE Z80 "UPGRADE" KIT

Change your JADE 2MHz Z80 to a 4MHz version with this simple kit:

only $17.95 with trade
$49.95 purchase.

To trade, you must give us your 2MHz Z80 chip and 8224 clock driver.

The "UPGRADE KIT" includes:

Z80A chip,	1.8K resistor
8224-4 clock driver	20pf. capacitor
36MHz crystal	

COMPU/TIME CT 100

S100 BUS COMPATIBLE

TIME & CALENDAR

Microprocessors need the power that a real-time clock can offer. Date and time becomes instantly available. COMPU/TIME does not have to be initialized every time the system is powered up. It possesses a crystal-controlled timebase to obtain superior accuracy and has two setable coincidence counters. Time, date, and counters are set via software.

COMPUTATIONAL FUNCTION

Microprocessors need to be complimented by hardware arithmetics to free up memory pages dedicated to floating point routines and mathmatical software. COMPU/TIME provides a 40 function calculator array so that algebraic, trigonometric, basic arthmetic problems can be solved without the need of developing sophisticated software.

Buy It Your Way

COMPU/TIME	CT100	$199	KIT	$245	Assembled
COMPU only	C101	$149	KIT	$189	Assembled
TIME only	T101	$165	KIT	$205	Assembled
COMPU/TIME	PC Board only	$80			

JADE VIDEO INTERFACE KIT

FEATURES $99.95

S-100 Bus Compatible
32 or 64 Characters per line
16 lines
Graphics (128 x 48 matrix)
Parallel & Compositive video
On board low-power memory

Powerful software included for cursor, home, EOL, Scroll Graphics/Character, etc.
Upper case, lower case & Greek
Black-on-white & white-on-black

full ASCII PROFESSIONAL KEYBOARDS

Full 128 Character ASCII!
Tri-Mode MOS Encoding!
MOS DTL TTL Compatable Output!
Two-key Rollover!
Level and Pulse Strobe!
Shift and Alpha Lock!
Selectable Parity!
Positive or Negative Logic!

MODEL 756 (56 keys)

PRICING INFORMATION

Model 756 (assembled)	$75.95
Model 756K (kit)	64.95
Model 702 Enclosure	29.95
Model 710 Numeric Pad	9.95
Model 756MF Mtg Frame	8.95

CONNECTORS

DB – 25P	$3.00
DB – 25S	$4.00
COVER	$1.50
44 Pin – PC & EYE	$1.95
44 Pin – WW	$2.50
86 Pin – (6800) PC	$5.00
86 Pin – (COSMAC ELF) PC	$5.00
100 Pin – (Altair) PC	$4.50
100 Pin – (Imsai) PC	$3.75
100 Pin – (Imsai) WW	$4.25

WE HONOR master charge THE INTERBANK CARD

JADE REAL TIME CLOCK FOR S-100 BUS

1 MHZ Crystal Oscillator
Two independent interrupts
One interrupt uses 16 bit counter in 10 USEC steps
Other interrupt is in decade steps from 100 USEC to 10 sec.
Both software programmable
Board can be selected by 128 device code pairs.
Complete documentation includes software to display time of day.
Double sided solder mask
Silk screen parts layout

JG–RT ASSEMBLED & TESTED	$179.95
JG–RT KIT	$124.95
BARE BOARD with Manual	$30.00

TARBELL CASSETTE INTERFACE

- Plugs directly into your IMSAI or ALTAIR*
- Fastest transfer rate: 187 (standard) to 540 bytes/second
- Extremely Reliable— Phase encoded (self-clocking)
- 4 Extra Status Lines, 4 Extra Control Lines
- 37-page manual included
- Device Code Selectable by DIP-switch
- Capable of Generating Kansas City tapes also
- No modification required on audio cassette recorder

JADE KIT* $99.95 ASSEMBLED $175.00
*(6 month warranty - from JADE) MANUAL $4.00

JADE PARALLEL/SERIAL INTERFACE KIT

S-100 $124.95 KIT

2 Serial Interfaces with RS232 interfaces or 1 Kansas City cassette interface.
Serial interfaces are crystal controlled.
Selectable baud rates.
Cassette works up to 1200 baud.
1 parallel port.

DATA COMMUNICATIONS ADAPTER

80-103A: Serial I/O and FSK modem for professional and hobby communications.

- Completely compatible with your IMSAI, ALTAIR* SOL** or other S-100 microcomputers. Trademarks of *MITS, **Processor Technology
- Designed for use on the dial telephone or TWX networks, or 2-wire dedicated lines, meets all FCC regulations when used with a CBT coupler.
- All digital modulation and demodulation with on board cyrstal clock and precision filter mean that NO ADJUSTMENTS ARE REQUIRED
  - Bell 103 standard frequencies
  - Automated dial (pulsed) and answer
  - Originate and answer mode
  - 110 or 300 BPS speed select
  - Complete self test capability
  - Character length, stop bit, and parity
  - 90 day warranty and full documentation

PRICES:

BARE BOARD and Manual	$49.95
Assembled (48 hr. burn in)	$279.95
JG–DCA KIT	$159.95

NUMBER CRUNCHER

The CT200 is a number-oriented microprocessor intended for use in those applications that require fast versatile mathematical solutions.
THIS IS NOT A CALCULATOR CHIP. THERE ARE NO KEY DELAYS.
The CT200 has a unique architecture that is designed to be a TASK processing system within a system. This unique architecture will allow the CT200 to work and run with ANY S100 BUS microprocessor system. It is completely compatible with Z80, 4MHZ version also, 8080, 6800, 6502 microprocessor. A micro incoded instruction set allows programming in a calculator like language. The instruction set includes a full set of test and branch instructions. All decoding of S100 bus signals (for select or control functions) is performed with strobed latches to eliminate the possibility of glitches.

PRICE: $249.00
Includes - Manual, ASSEMBLED & TESTED.

JADE Computer Products

BANKAMERICARD VISA

5351 West 144th Street
LAWNDALE, CALIFORNIA 90260
(213) 679-3313

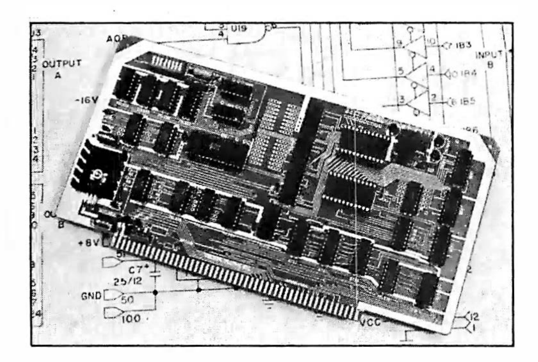
RETAIL STORE HOURS Monday - Friday 9–7
Saturday 9–5

Discounts available at OEM quantities. ADD $1.50 under 10 lbs. for shipping. California residents add 6% sales tax.

NEW CATALOG NOW AVAILABLE

Circle 195 on inquiry card.

Parallel and Serial IO



A new peripheral board, called the Bit Streamer, is now available in assembled or kit form from Vector Graphic Inc, 790 Hampshire Rd, Westlake Village CA 91361. According to the company, the Bit Streamer combines two parallel input and output ports, and a serial IO port using an 8251 programmable universal synchronous or asynchronous receiver and transmitter USART. One parallel port also can be used as a keyboard input port. The USART is designed to interface easily to an S-100 bus structure and is capable of being configured for a wide variety of communication formats. The price is $195 assembled and $155 for the kit. Technical data covering the Bit Streamer and other products may be obtained from the company.■

Circle 624 on inquiry card.

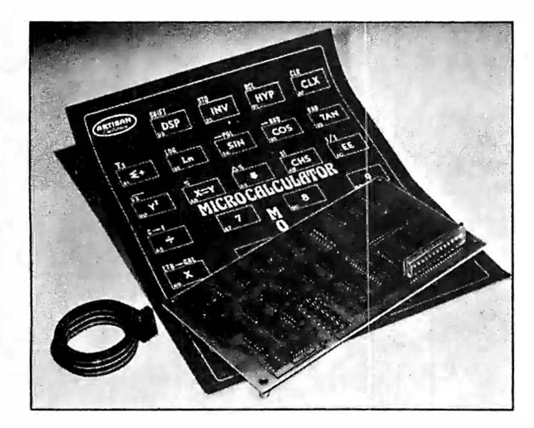
A New Audio Cassette Interface



This standard PerCom CIS-30+ interfaces with the MITS 680b computer. The unit interfaces two cassette recorders and a data terminal to a microcomputer using the 6800 processors. It provides user selected data rates of 300, 600 or 1200 bps. The two cassette interfacing circuits are independent and simultaneous dual tape operations are possible. Optional program control of recorders is available. Cassette data recording is done using the Kansas City Standard (bi-phase-M, double frequency). The data terminal communication mode is full duplex. The MITS 680b read only memory monitor may be used for loading running programs, except for flipping the tape switch to on for program loading. The CIS-30+ sells for $79.95 in kit form, and $99.95 assembled and tested. An instruction manual is included. Contact PerCom Data Company, 318 Barnes, Garland TX 75042.■

Circle 625 on inquiry card.

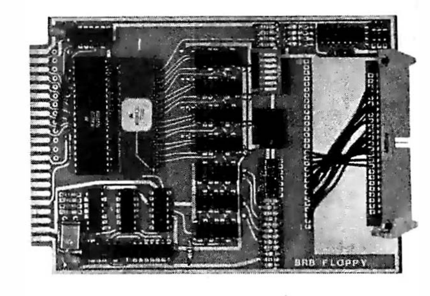
Add a Programmable Scientific Calculator to Your System



This new microcalculator, Model 85, is intended for operation with an 8 bit microprocessor. The Model 85 requires only +5 V for operation and interfaces with the microprocessor thru an 8 bit bidirectional IO port. Each entry that would normally be made by a key is replaced with an 8 bit instruction from the microprocessor. The number of input instructions is not limited, restricted only to the user program or the amount of memory in the microprocessor system. Instruction entry to the microcalculator is under microprocessor software control. It accepts instructions, provides a means to detect busy status, and outputs the 14 digit display back to the microprocessor for storage or display. Complete software for controlling the microcalculator in both read and write modes requires less than 256 bytes of microprocessor system memory. The Model 85 has scientific calculation capabilities for handling scientific engineering, mathematical or statistical problems. Priced at $189 from Artisan Electronics, 5 Eastmans Rd, Parsippany NJ 07054.■

Circle 626 on inquiry card.

Floppy Controller Uses New Motorola Chip



The new Motorola MCM 6843 floppy disk controller integrated circuit has been incorporated into a low cost but versatile floppy disk controller. The 4½ by 6½ inch (11.4 x 16.5 cm) module interfaces to any full size or minifloppy disk drive. The module supports both hard and soft sectoring, IBM 3740 or user programmable read and write format, automatic CRC generation and checking, and programmable step and settling times. The price is $199. Contact Wintek Corp, 902 N 9th St, Lafayette IN 47904.■

Circle 627 on inquiry card.

Moving Head Disk Controller for LSI-11 Systems



The PX-C45L moving head disk controller enables you to add up to 40 megabytes of storage to DEC PDP-11/03, VO3 Systems. It is Q-BUS compatible and equipped with a 5 or 10 megabyte disk drive. The controller is compatible with RT-11, FORTRAN, BASIC and other LSI-11 software. When used with a 5 megabyte disk drive, the removable media is interchangeable with DEC RK05 disk media. The unit is supplied in a 19 inch (48.3 cm) rack mountable 5¼ inch (13.3 cm) chassis complete with bootstrap loader, +5 V, 25 A power supply, slides, cardcage assembly fans and a 5 or 10 megabyte disk drive. An 8 foot (2.4 m) flat cable extends to the PDP-11/03 Q-BUS and three prewired Q-BUS IO slots are available for user peripheral devices. The PX-C45L may be purchased separately or as part of a complete disk system. Contact Xylogics OEM Components Group Inc, 42 Third Av, Burlington MA 01803.■

Circle 628 on inquiry card.

Circle 115 on inquiry card.

Electrolabs

PO Box 6721 Stanford, CA. 94305
415·321·5601

Educational Grade VIDEOTAPE Special: ½"x2400' 20 boxes/$125.00

The "Pro" fully encoded ASCII Keyboard by Cherry. Auto REPEAT feature, 5 special function keys. 300mA/5V. *(Shown as mounted in 'The Case', Below)* **$119.00, 3/99.00, 10+/89.00**

USED SYLVANIA 12" MONITORS
You Fix: $24.95
Working: $69.95
Cold Chassis, 25lbs.

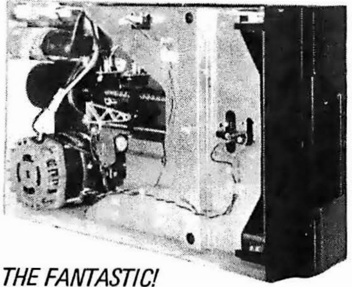
The Dumb Terminal for Smart People

80X24 with full 128 char. ASCII UC+LC font with all control characters displayed. 300-19,200 baud RS232. 2nd font addressable from keyboard in you-program-it 2708 for APL, Graphics sets, etc. Plug in monitor I/O connector, 110VAC and you are ready. INCLUDES: 'The Case', Cherry Kbd. A used monitor, ESAT 200A, all options except vector addressable cursor and modem. Bulletproof design and construction. Normally $675.00 What you always wanted your ADM3 to be:

SYSTEM"A" $649.00 10/$599.00



"The Case" Beautiful and sturdy anodized aluminum case in deep black designed to contain the ESAT 200A, and with a bezel cut out for the Cherry 'Pro' keyboard. (installed as shown above) Choose deep brown, light yellow, or crimson to accent or color code your installation. The only choice for hard-use institutional and educational applications. **$69.00, 10/ 59.00**



THE FANTASTIC!

MEMOREX FIVE-FIFTY

* *Hard and Soft Sectoring*
* *Single and Dual Density*
* *Double side configuration as a retrofit at any time.*
* *110/220V, 50/60Hz*
* *Pin for pin compatable with Shugart 800,801,850,851 (50 pin edge connector)*

$536, 2/499, 5/475, 10/449 25/425, 100/405

Double Sided Retrofit **$200**

Verbatim

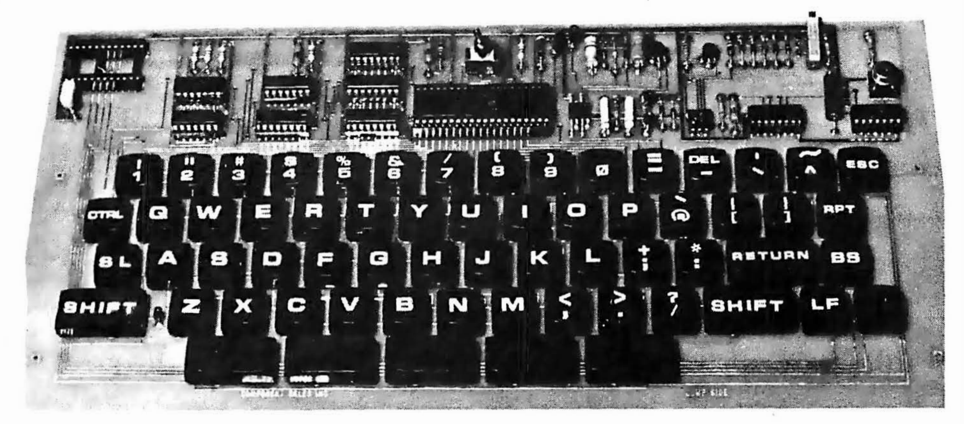
	1-9	10-24	25+
MINIDISKETTES (5.25')			
10, 16 or Soft Sector	$4.79	4.65	4.45
STANDARD (8') DISKETTES			
Hard or Soft Sector	$5.99	5.33	4.79
CASSETTES			
R-300 Certified Phillips Type	$5.25	4.99	4.35
I-150 Certified for audio decks ('Kansas City' & SWTP formats)	$4.60	4.30	3.90

SURPLUS *Muffin type fans $7.95, Lambda Power Supplies 5V/70A-$145.00, 35A-$89.00, 16A-49.00, 12V/7.3A-$69.00*

OUR CATALOGUE *Contains IC's, T.I. Sockets (1cent/pin) Advice and much more. It is free.*

Shipping and Handling: Surface: $0.40/lb. **Air:** $0;75/lb., 1.00 minimum
Cal. Tax: 6.5% **Insurance:** $0.50 per $100.00

Stand Alone ASCII Keyboard Specification



$138⁰⁰

ASSEMBLED AND TESTED

Plus $3.00 handling charge. California residents add 6½% sales tax.

- ☆4 SIMULTANEOUS OUTPUTS AVAILABLE: THE ONLY ONE ON THE MARKET
  1. SERIAL TTL LEVEL
  2. BUFFERED 8 BIT (TRI-STATE LATCH) PARALLEL OUTPUT WITH VALID DATA SYNC PULSE AND LEVEL
  3. 20 MA OPTO-ISOLATED CURRENT LOOP, POLARITY INDEPENDENT
  4. EIA RS232C
- ☆SINGLE +5 VOLT 300 MA (NOMINAL) POWER SUPPLY (REQUIRED)
- ☆INDUSTRY STANDARD 2 KEY ROLLOVER ENCODER
- ☆ANSI–COMPATIBLE KEY SET; FOR SLIM-LINE "HIDE-AWAY" PACKAGING
- ☆SEGMENTED SPACE BAR ALLOWS FAST MULTIPLE-SPACING WITHOUT REPEAT KEY
- ☆REPEAT KEY REPEATS AT CHARACTER RATE
- ☆USER SELECTABLE UPPER CASE ONLY (KSR/ASR/33 REPLACEMENT) OR UPPER/LOWER CASE
- ☆FACTORY SET AT 110 BAUD BUT EASILY ADJUSTED BY USER TO ANY BAUD RATE FROM 110 TO 9600 BAUD
- ☆FLEXIBLE PARITY
- ☆LED INDICATOR FOR SHIFT-LOCK KEY ELIMINATES CASE UNCERTAINTY
- ☆24 PIN DUAL–INLINE CONNECTOR
- ☆LOW PROFILE CASE (OPTIONAL) $40.00

COMPONENT SALES INC.
778-A BRANNAN, SAN FRANCISCO, CA 94103
(415) 861-1345



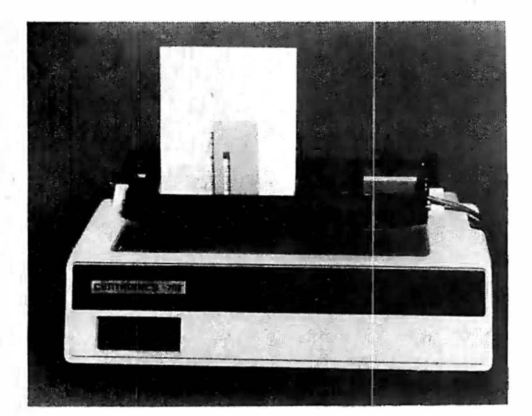
Orders accepted by phone or mail.



MASTERCHARGE ☆ VISA ☆ COD ☆ CHECK ☆ MONEY ORDER

Circle 60 on inquiry card.

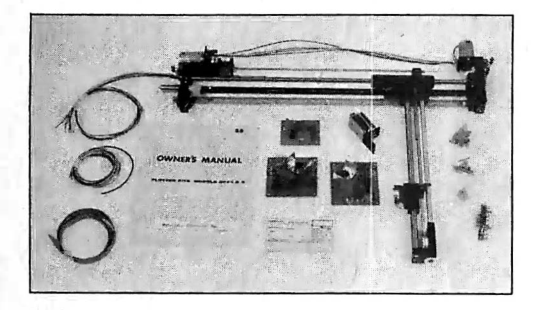
Centronics Announces Front Feed Option for 700 Series Printers



An optional front feed device has been introduced by Centronics Data Computer Corp, Hudson NH 03051. The front feed is designed for use on eight members of the firm's 700 series of dot matrix printers and permits automatic front insertion of cut forms and cut multipart form sets. It can be used in any application that requires information for immediate utilization, including invoicing, accounting, banking and stock certificates. The price for the front feed option is $700.■

Circle 639 on inquiry card.

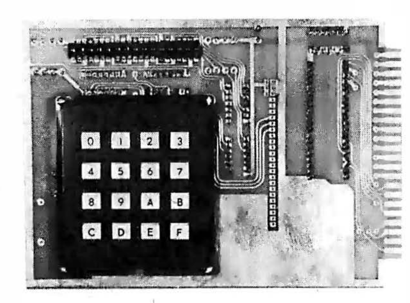
Assembled and Kit Plotters



Plotter kits and plotters completely assembled are offered by Sylvanhills Laboratory Inc, POB 646, Pittsburg KS 66762. The kits require the purchaser to mount them on a drawing surface and to do the interconnection between the control printed circuit boards and the computer. Plotters require an 8 bit parallel IO port and 5 and 24 V power sources. A basic 8080 software program is included in the owner's manual. Applications include architectural, mechanical, and schematic drawings; printed circuit board artwork; positioning of small objects; computer generated art; games; etc. Sizes available are 11 by 17 inches (30 by 43 cm) at $795 in kit form, 17 by 22 inches (43 by 56 cm) at $950 in kit form, and 22 by 34 inches (56 by 86 cm) at $1300 in kit form.■

Circle 640 on inquiry card.

Micromodule Has 16 Keys and 15 Displays



This new Wince console IO module provides a versatile but inexpensive means of communication between a human operator and a microprocessor. A 16 key keyboard allows entry of parameters such as product codes, gas chromatograph stream selects, etc, and 15 7 segment displays. It allows output of data such as torque, item counts, etc. Also included is a real time clock for providing interrupts and displaying time. For further information contact Wintek Corp, 902 N 9th St, Lafayette IN 47904.■

Circle 641 on inquiry card.

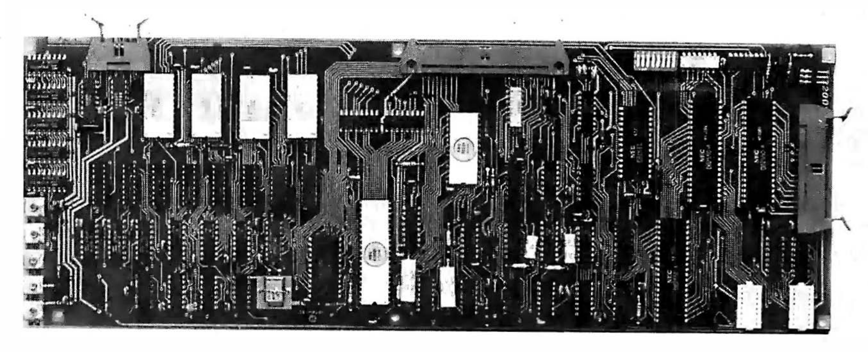
Add Some Color



The RM 9050 series, a new family of raster scan color imaging and graphic systems, has been announced by the Ramtek Corp, 585 N Mary, Sunnyvale CA 94086. The RM 9150, 9250, 9350 and 9351 are the first members of a compatible family of solid state digital television image generation systems capable of displaying in color, gray scale and black and white. The series was developed to provide a basic imaging system plus graphics (plots, vectors and bar charts) and alphanumeric capability. The basic system includes scrolling, character scaling, readback, cursor and interactive capabilities. An assortment of custom video boards are available providing enhancement lookup tables and digital to analog converters which can produce from 256 gray levels to 4096 different colors. Keyboards and cursor controllers are available as add-on options. Pricing for a basic 64 color system is under $6000 with black and white less than $5500.■

Circle 642 on inquiry card.

Speed Up DECwriters



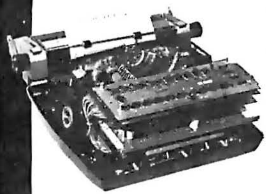
The SuperDEC throughput optimizer is a printed circuit board designed to replace the existing digital electronics in Digital Equipment's LA361 DECwriter 11 teleprinter, upgrading it to 1200 bps. Installation of the optimizer takes less than five minutes and is completely plug compatible with the cables in the DECwriter. Standard features include automatic and manual top of form, full horizontal and vertical tabs (addressable and absolute), adjustable right and left margins and an RS-232C interface. Features not previously offered to DECwriter users include a double wide character set, bidirectional printing and 32 user programmable characters. An APL character set, selective addressing and an answer back feature are optional. Price is $395 with a one year warranty on all parts and workmanship. Contact Intertec, 19530 Club House Rd, Gaithersburg MD 20760.■

Circle 643 on inquiry card.

California Industrial

Post Office Box 3097 B • Torrance, California 90503

WORD PROCESSING PRINTER



This Rube Goldbergized printer, when properly interfaced to your data processing system, offers the capability of producing error free duplicate personalized letters.

A seven bit TTL signal directs one of the 50 solenoid driven fingers to depress the proper typewriter key. Expandable incremental spacing allows the operator to software control justified copy.

The heart of this machine is an Executive "D" serviceable by any IBM repair center.

Shipping east of the Mississippi add $20.00; California add $10.00 all other states add $15.00.

(Copy above reduced to half size.)

$235.

IBM EXECUTIVE D"

S-100 Mother Board

Quiet Buss ™

$29.95

The Quiet Buss from California Industrial is quality engineered. No short cuts have been taken to produce this mother board. Active termination circuitry prevents noise and crosstalk. Manufactured from extra heavy FR-4 epoxy glass.

18 slot IMSAI

TELETYPE® MODEL 43

New from Teletype, the Model 43 is capable of printing 132 ASCII characters per line. Send and receive data at 10 or 30 char. per second. Keyboard generates all 128 ASCII code combinations. RS-232 interface, same as the popular Model 33. Data sheet sent upon request. Manufacturer suggested price $1377.00.

IMMEDIATE DELIVERY $1219

TTL model with NOVATION brand Acoustic Modem. $1419



HEXADECIMAL KEYBOARD

$34.95

Maxi-Switch hexadecimal keyboards are designed for microcomputer systems that require 4-bit output in standard hex code.

Each assembly consists of 16 hermetically sealed reed switches and TTL "one shot" debounce circuitry.

Reliable low friction acetal resin plungers are credited for the smooth operation and long life of this premium keyboard.

Requires single + 5 volt supply.

MAXI-SWITCH ASCII KEYBOARD

NEW

Fully Assembled **$64.97**

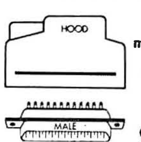
Definitely the best small system keyboard that we have seen. Maxi-Switch has incorporated all the important keyboard features at a reasonable price. Full 128 ASCII functions, "N" key rollover, automatic repeats, user designated special function keys, escape, control & lots of others. Data sheet upon request.



CONNECTORS

your choice
DB25P male plug & hood
or
DB 25S female

$3.95



Qty.	fe.	male	hd.
10	3.45	2.45	1.15
25	3.15	2.25	1.05
100	2.85	1.90	.95
500	2.25	1.60	.85
1K	1.97	1.37	.73

Edge Connectors



100 PIN IMSAI/ALTAIR

S-100 • GOLD PLATED • .125" CENTERS

Altair .140 row, soldertail...... $5.98 3/$16.50
Imsai .250 row, soldertail...... $4.98 3/$11.95
3 Level Wire Wrap .250 row... $4.98 3/$13.00

SPECIALS

W/W same as above without ears $3.50 3/$10
72 (dual 36) W/W .156" centers... $2.50 3/$6

SPERRY UNIVAC KEYBOARD



$24.88

The famous Sperry Univac 1710 Hollerith keyboard assembly is now available from California Industrial for only $24.88. The ideal computer input device for accountants and mathematicians. The numeric keys are placed on the lower three rows to resemble a ten key adding machine. This format allows one handed numeric data entry.
Original cost was $385. Used but guaranteed in excellent condition. Complete with documentation.

FROM ATARI COLOR TELEVISION R.F. MODULATOR

$13.95



Assembled

The Atari R.F. Modulator allows computer data to be displayed directly upon your existing television system. This unit converts the signal from the Apple II and other video sources into television frequencies. Operates from single 5 volt supply. Complete with metal case, mating R.F. connector and 15 feet of coax cable. Schematics and instructions included.

FREE

MANUAL GRAPHITE DISPLAY GENERATOR

Modern technology has pioneered the development of this unique character printer. Our Manual Graphite Display Generator has the capability of producing the full upper and lower case ASCII set. Self contained cursor assembly allows the operator to eliminate erroneously entered information.

Each unit is manufactured to strict tolerances as prescribed by standards set forth by California Industrial. One free with every order.

Scotch® Certified Digital CASSETTES

$4.98
10 for $45.



Won't drop a BIT!

$5.50

DISKETTES
8 inch Soft (IBM)
8 inch 32 sector
Mini Soft sec.
Mini 10 sector
Mini 16 sector





CALIFORNIA INDUSTRIAL is an Authorized Dealer of Scotch Brand Data Products

JOYSTICK $4.50

3 for $10.00

This joystick feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Perfect for television games, quad stereo and radio controlled aircraft.

450ns 2708

$9.95

8K UV Erasable MEMORY

Potter & Brumfield REED RELAY

5 volt coil, pulls 3.5v.

$1.19 ea.



SPST

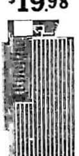
10	100	1K
.97	.79	.65

S-100 PROTOTYPE BOARD

$19.98

GP100-Maximum design versatility along with standard address decoding and buffering for S100 systems. Room for 32 uncommitted 16 pin IC's, 5 bus buffer & decoding chips, 1 DIP address select switch, a 5 volt regulator and more.

WW100-Wire wrap breadboard, similar to the GP100. Allows wire wrap of all sizes of sockets in any sizes of sockets in any combination. An extra regulator position for multiple voltage applications.



21L02

LOW POWER 450 nS

$1.19

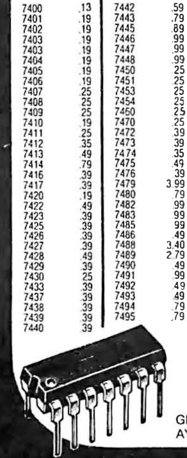
SUPER BUY! Lowest Price Anywhere

Our low power static RAMs are factory prime. Purchased, on contract, directly from one of California's leading semiconductor manufacturers.

Access time guaranteed faster than 450nS. Minimum purchase 32 pieces.

Sorry, credit cards can not be accepted on 21L02's.

7400	.13	7442	.59
7401	.19	7443	.79
7402	.19	7445	.89
7403	.19	7446	.99
7403	.19	7447	.99
7404	.19	7448	.99
7405	.19	7450	.25
7406	.19	7451	.25
7407	.25	7453	.25
7408	.25	7454	.25
7409	.25	7460	.25
7410	.19	7470	.25
7411	.25	7472	.39
7412	.35	7473	.39
7413	.49	7474	.35
7414	.79	7475	.49
7416	.39	7476	.39
7417	.39	7479	3.99
7420	.19	7480	.79
7422	.49	7482	.99
7423	.39	7483	.99
7425	.39	7485	.99
7426	.39	7486	.49
7427	.39	7488	3.40
7428	.49	7489	2.79
7429	.39	7490	.49
7430	.25	7491	.99
7433	.39	7492	.49
7437	.39	7493	.49
7438	.39	7494	.79
7439	.39	7495	.79
7440	.39		



7496	.79
7497	3.99
74100	1.19
74107	.39
74109	.49
74110	1.79
74116	1.99
74120	1.79
74121	.39
74122	.39
74123	.69
74125	.59
74126	.59
74128	.49
74132	.99
74136	.89
74141	.99
74145	.99
74147	2.49
74148	1.99
74150	1.19
74151	.99
74153	.89
74154	.99
74155	.99
74156	1.29
74157	.99
74159	2.99
74160	1.19
74161	.99
74162	1.49
74163	.99
74166	1.19
74167	4.99
74170	2.49
74173	1.49
74174	1.19
74175	.99
74176	.99
74177	.99
74192	.99
74193	.99

CMOS

4001	.25
4002	.25
4006	1.99
4007	.25
4008	1.49
4009	.69
4010	.69
4011	.25
4012	.25
4013	.49
4014	1.49
4015	1.39
4016	.69
4017	1.29
4018	1.69
4019	1.79
4020	1.39
4021	1.49
4022	1.25
4023	.25
4024	1.19
4025	.25
4027	.69
4028	1.25
4029	1.99
4030	.69
4032	.49
4033	1.99
4035	1.69
4040	1.99
4041	1.49
4042	1.49
4043	1.49
4044	1.49
4046	2.49
4047	2.49
4049	.79
4050	.79
4051	1.99

CPU's

8080A	14.95
6800	24.95
Z80	39.95

MEMORY

1702A	4.95
82s23	2.95
82s123	2.95
2102	1.79
2102-1	1.89
21L02	1.19
250nS	1.49

CLOCK's

5314	2.95
5316	4.95
5375	3.95

LM741

SOLD OUT

301H	.39	350N	.99
301CN	.39	351CN	.65
302H	1.29	370H	1.29
304H	1.29	370N	1.29
305H	.99	373N	3.19
307H	.49	377N	3.99
307CN	.39	380N	1.39
308H	.99	381N	1.79
308CN	.99	382N	1.79
309H	1.09	NE555v	.49
309K	.99	NE556	1.29
310H	1.19	NE565H	1.49
310CN	1.19	NE565N	1.79
311H	.99	NE566N	1.25
311N	.99	703CN	.45
312H	1.99	709H	.39
318H	1.79	709N	.39
318CN	1.49	710N	.79
319CN	1.29	711H	.39
320K-5	1.19	711N	.39
320K-12	1.19	723H	.55
320T-5	1.19	723N	.55
320T-12	1.19	725H	3.49
340K-5	1.19	733H	1.49
340K-12	1.19	733N	.99
340T-5	1.19	739N	1.19
340T-12	1.19	741N	.09
		747N	.79
		748H	.39
		748N	.39
		1414N	1.75
		1458	.69

(320K-5 through 340T-12: bracketed together at 1.19)

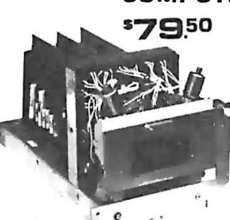
UART
AY 5-1013A
$4.98

SPECIAL
GENERAL INSTRUMENT ASCII Keyboard Encoder
AY 5-3600 Prime but house marked only $4.95

Digital Cassette Drive

COMPUTER CONTROLED

$79.50



This precision I/O assembly features remote software controlled search capabilities. Two independent capstan drive motors allow the computer to control direction and speed of the transport.

The assembly consists of a Raymond cassette transport, chassis, motherboard and three edge cards: read/write, capstan drive & control card.

Current replacement valued at over $700.00. Schematics and complete documentation included. USED, but in excellent condition.

Thumbwheel switch

Ten position **BCD**

$1.39 ea.

10	50
$1.19	.89



MINIATURE SWITCHES

your choice

$.98

10	50	100	1k
$.88	.81	.73	.66

SPDT Miniature Toggles

7101 C&K ON-NONE-ON
7107 jbt ON-OFF(mnt.ON)
7108 CK ON-(moment.ON)
Rocker JBT ______ DPDT
Rotary 3P-4-Pos.
Rotary 3P-6-Pos.
Push B (N.O.) $.39ea. 4/$1

CAPACITORS

ELECTROLYTICS

	ea.	10	50
80,000/10v.	3.95	3.49	2.95
4500/50v.	$1.49	1.35	1.19
1000/15v axial	$.55	.49	.45
.1 disc	$.12	.09	.07
.01 disc	.06	.05	.04

DIP Switch

$1.49 ea.

10	25	100	1K
$1.29	1.15	.97	.85

specify 7 or 8 pos.



50 Conductor RIBBON WIRE

$.69 Ft.

TWISTED PAIR

Power Adapter

6 vdc, 140mA $1.39
7 vdc, 1.4 A. 5.50
9 vdc, 15mA. 1.19
10 vAc, 300mA. 1.95

RELAYS

SPDT MINIATURE

$1.19 ea.

10	25	100
$1.15	1.04	.89

Coil 12 Volt dc.
7 Amp Contacts
P. C. Board Mount

Transistors

	ea.	10	50	100
2N2222A	.20	.18	.16	.15
2N3055	.69	.65	.59	.55
MJ3055	.79	.75	.69	.65
2N3772	1.59	1.49	1.39	1.29
2N3904	.15	.11	.09	.07
2N3906	.15	.11	.09	.07

Diodes

		10	25	100
1N4002	100v.	.08	.06	.05
1N4005	600v.	.10	.08	.07
1N4148	signal	.07	.05	.04

jumbo red LED's

ea.	10	25	100
$.15	.13	.11	.09

BINDING POSTS 5-WAY

3 for $1.19

20	100
$.35	.29

9 foot

$1.49

Heavy duty grounded power cord and mating chassis connectors.

SOLDERLESS TERMINALS

INSULATED
20 for $.98
Specify: 22-18; 16-14

100	500	1k
4.50	20.	35.

PANASONIC

$.98

Nicad "AA" 450mA.

DISCOUNT Wire Wrap Center

IC SOCKETS

pin	wire wrap ea.	25	50	low profile ea.	25	50
8				17¢	16	15
14	37¢	36	35	18	17	16
16	38	37	36	19	18	17
24	99	93	85	36	35	34
40	169	155	139	63	60	58

50ft. **$.98** **KYNAR WIRE WRAP**

500	1,000	11,000
$9.	$15.	$105.



$29.95 BW630

OK HOBBY WRAP-30 wire wrap & strip tool **$5.45**

(213) 679-9001

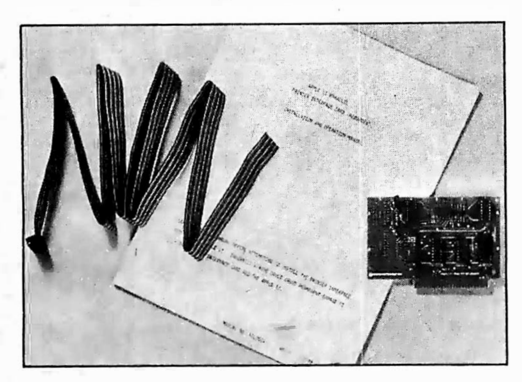
All merchandise sold by California Industrial is premium grade.
Orders are shipped the same day received.
PLEASE INCLUDE $1.00 SHIPPING ON ORDERS UNDER $15.00
California residents add 6% sales tax • Money back guarantee.
Sorry, no COD's • Foreign orders add 10%
Credit cards accepted, $20 minimum





Circle 39 on inquiry card.

Intelligent Parallel Printer Interface Card for Apple II Computer

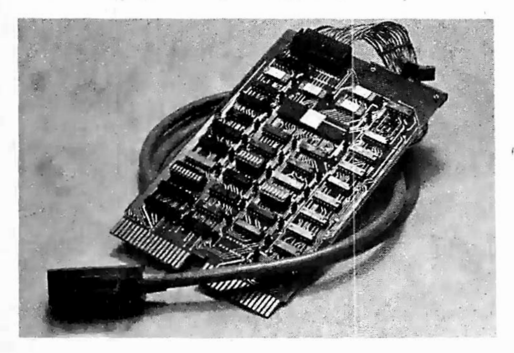


Apple Computer Inc has introduced the Model A2B0002X intelligent printer interface card. The unit gives Apple II owners hard copy from popularly priced printers such as those offered by Axiom, Centronics, Qume, Printronics, OKI Data, SwTPC and other. Users can produce permanent copy of program listings, generate reports, print letters and labels and generate graphics on printers with graphic capability. It comes fully assembled with instructions for connecting it to a printer. The card has a wide line format, capable of handling line widths up to 255 characters per line. It features high speed operation, up to 5000 characters per second, the equivalent of 3700 lines per minute at 80 characters per line. The power requirement is low, as card components are automatically powered down when no printing occurs and no external power is required for the card. It also features a general purpose 8 bit parallel output port. The card comes with firmware in read only memory, printer configuration block, ribbon cable and instruction manual.

The price of the A2B0002X is $180. Contact Apple Computer Inc, 10260 Bandley Dr, Cupertino CA 95014.■

Circle 619 on inquiry card.

LSI-11 to Instrumentation Bus



National Instruments, 8330 Burnet Rd, Austin TX 78758, has announced an interface from the Digital Equipment Corporation LSI-11 to the IEEE standard 488-1975 general purpose interface bus (GPIB). The unit, designated the GPIB11V-1, can be used with either the LSI-11 or Heath H11. The unit is furnished with a 4 meter bus cable and a complete software package including drivers, utilities, and diagnostics. The drivers and utilities are furnished as MACRO source files which can be assembled as FORTRAN, BASIC or MACRO callable subroutines. The interface can be used with such GPIB devices as voltmeters, counters, frequency synthesizers, and other controllers such as the PET microcomputer. The unit, including software and cable, sells for $695.■

Circle 620 on inquiry card.

New Improved TV Modification Kit



The TVM-04 television modification kit (see May 1978 BYTE, page 22) has been superseded by the improved TVM-41, allowing greater monitor bandwidth than with the TVM-04. The new 80 character video generator displays look crisp and sharp. Operation as a monitor or TV receiver is switch selectable. The TVM-41 also extends the number of sets which can be modified to include Hitachi model number P-04, P-05, P-08, PA-4, PA-5, PA-8, P-40, P-41, (all 12 inch) and the 9 inch model I-28. Total cost for the monitor is about $100, depending on the local price of the TV set. The TVM-41 is priced at $20 including hardware, wire and a five foot video cable for connecting to your video source. For more information contact Pickles & Trout, POB 1206, Goleta CA 93017.■

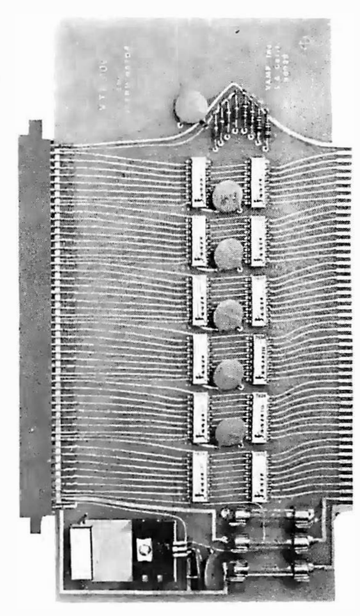
Circle 621 on inquiry card.

"OEM II" Brochure on Open Frame DC Power Supplies

A new 12 page, illustrated brochure is now being offered by Powertec Inc, 9168 DeSoto Av, Chatsworth CA 91311 that describes the company's OEM II series of second generation, open frame DC power supplies. Described in the brochure are Powertec's broad product range of single output low power to 375 W, and multiple outputs dual and triple power supplies. The printed circuit board electronics have been designed to provide high efficiency and low primary power consumption. A listing of specifications is also included. Voltage and current rating charts are listed for user convenience.■

Circle 622 on inquiry card.

Glitch Exterminator for the S-100 Bus



Vamp Inc has introduced the Exterminator (VTE-100) which they claim puts an end to bus problems on S-100 computer systems. The VTE-100 is a dual function board serving as a bus terminator and card extender. Bus termination by the VTE-100 is said to clean up noise, cross talk, overshoot and other bus problems that can scramble data unpredictably. The board also serves as a card extender for memory or IO cards which may require analysis or maintenance. The Exterminator, through on board termination, eliminates interference from adjacent boards which may radiate digital RF allowing any memory or IO card to be extended without fear of having the board perform unpredictably. It fuses all extended power buses to protect both the extended card and the power supply from any accidental damage. The fuses also allow for easy access to all power buses to permit the monitoring of current consumption. The Exterminator comes fully assembled and tested for $49.95 plus $2 to cover shipping and handling from Vamp Inc, POB 29315, Los Angeles CA 90029.■

Circle 623 on inquiry card.

Circle 297 on inquiry card.

✶ YOUR BEST BUY IN WIRE WRAP SUPPLIES ✶

PRECUT WIRE

WHY BUY WIRE ON ROLLS?

PRECUT & STRIPPED WIRE IS:

- **Fast** - No more cutting & stripping by hand
- **Reliable** - Good, clean, uniform strip
- **Economical** - Cheaper than using bulk wire

Precut Wire	Bulk Wire
100 pcs of 3" at $.82 = 3¼¢/ft.	50 ft roll at $1.99 = 4¢/ft.
100 pcs of 6" at 1.06 = 2¢/ft.	100 ft roll at 2.95 = 3¢/ft.
Wire Kit 1 at $6.95 = 2 1/3¢/ft.	

30 Kynar stripped 1" on each end. Lengths are overall.
Colors: Red, Blue, Green, Yellow, Black, Orange, White
Wire packaged in plastic bags. Add 25¢/length for tubes

	100	500	1000	5000
2½ in	.78	2.40	4.30/K	3.89/K
3 in	.82	2.60	4.71/K	4.22/K
3½ in	.86	2.80	5.12/K	4.55/K
4 in	.90	3.00	5.52/K	4.88/K
4½ in	.94	3.21	5.93/K	5.21/K
5 in	.98	3.42	6.34/K	5.52/K
5½ in	1.02	3.65	6.75/K	5.86/K
6 in	1.06	3.85	7.16/K	6.19/K
6½ in	1.15	4.05	7.57/K	6.52/K
7 in	1.20	4.25	7.98/K	6.85/K
7½ in	1.25	4.45	8.39/K	7.18/K
8 in	1.29	4.65	8.80/K	7.53/K
8½ in	1.32	4.85	9.21/K	7.84/K
9 in	1.36	5.05	9.62/K	8.17/K
9½ in	1.40	5.25	10.03/K	8.50/K
10 in	1.45	5.51	10.44/K	8.83/K
Addl. inches	.10	.41	.82/K	.66/K

WIRE KITS

#1 $6.95

250	3"	100	4½"
250	3½"	100	5"
100	4"	100	6"

#2 $19.95

250	2½"	250	4½"	250	6"
500	3"	250	5"	100	6½"
500	3½"	100	5½"	100	7"
500	4"	1 250 ft Roll Bulk			

Choose One Color or Assortment

WIRE WRAP SOCKETS

	1-9	10-24	25-99	100-249	250-999	1K-5K
8pin*	.41	.38	.35	.31	.29	.27
14pin*	.42	.39	.36	.32	.29	.27
16pin*	.46	.43	.39	.35	.32	.30
18pin*	.63	.58	.54	.47	.44	.41
20 pin	.84	.78	.71	.63	.59	.54
22pin*	1.30	1.20	1.10	.95	.90	.84
24 pin	.91	.84	.78	.68	.64	.59
28 pin	1.25	1.15	1.08	.95	.89	.82
40 pin	1.65	1.55	1.42	1.25	1.15	1.09

Gold 3-level Closed Entry Sockets
End & Side Stackable — All prices include gold
Tin sockets and 2-level sockets available

INTERCONNECT CABLES

Ribbon cable connectors for connecting boards to front panels, or board to board

	SINGLE ENDED			DOUBLE ENDED		
	14 pin	16 pin	24 pin	14 pin	16 pin	24 pin
6"	1.24	1.34	2.05	2.24	2.45	3.37
12"	1.33	1.44	2.24	2.33	2.55	3.92
24"	1.52	1.65	2.63	2.52	2.76	4.31
48"	1.91	2.06	3.40	2.91	3.17	5.08

WIRE WRAP TOOLS



$34.95

With Free Wire Kit 1 ($6.95 Value)
HOBBY WRAP
Model BW 630

Batteries & Charger	$11.00
WSU 30 Hand Wrap-Unwrap Strip Tool	5.95
WSU 30M, for Modified Wrap	6.95
BT 30 Extra Bit	2.95

WIRE WRAP BOARDS

				1-4	5-9	10-24	WW Connector
H-PCB-1	4x4½	44	Buses on both sides	4.75	4.50	4.00	3.00
3662	4x6	44	Blank	6.25	5.85	5.50	3.00
3682	4x10	44	Buses on one side	10.50	10.00	9.50	3.00
3682-2	4x6	44	Buses on one side	9.50	9.00	8.25	3.00
4066-4	4x6	72	Buses on both sides	13.50	13.00	12.50	4.00
3719-1	4x6	72	Blank	9.00	8.50	8.00	4.00
3719-4	4x10	72	Blank	11.00	10.50	10.00	4.00
4350	7x9½	80	Buses on both sides	17.50	16.50	16.00	7.00
8800V	10x5.3	100	Buses on both sides	19.50	17.96	16.95	5.00
169P84	8½x17	–	Blank	6.25	5.75	5.25	–

SOCKET SALE!

14 pin Gold WW Socket	.30	.27 per 400
16 pin Gold WW Socket	.32	.29 per 350
24 pin Gold WW Socket	.75	.65 per 117
44 pin ST Edge Card Connector	1.75	1.50 per 10
100 pin ST Edge Card Connector	3.50	3.00 per 10
100 pin WW Edge Card Connector	3.50	3.00 per 10

Prices good through 8/1/78 when purchased with Wire Kit #1 or #2

PAGE DIGITAL ELECTRONICS

Ordering Information:

- Orders under $25 and COD's, add $2
- All others, shipped Ppd in U.S. via UPS
- For Blue Label (Air) or 1st Class, add $1
- We accept Visa & Mastercharge
- Most orders shipped same day

Dealer Inquiries Invited

135 E. Chestnut Street 5
Monrovia, California 91016
Phone (213) 357-5005

P.O. Box 4430X Santa Clara, CA 95054
For will call only: (408) 988-1640
2322 Walsh Ave.

Quest ELECTRONICS

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

MICROPROCESSOR	
6800	19.50
8080A with data	8.95
Z80	29.95
8212	2.90
8214	8.00
8216	2.90
8224	2.95
8228	5.35
8251	9.25
8253	10.00
8255	9.25
CDP1802CD	19.95
CDP1802D	25.00
CDP1861	12.95
6820	9.95
6850	12.95
6502	18.50
PROM	
1702A	3.95
N82S23	2.95
N82S123	3.50
N82S126	3.75
N82S129	3.75
N82S131	3.75
N82S136	8.75
N82S137	8.75

2708	14.65
DM8577	2.90
8223	2.90
2716	28.95

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	.15	24	.35
14	.18	28	.42
16	.20	36	.58
18	.27	40	.61
22	.30		

3 level wire wrap gold.
14 pin .25 16 pin .27
2 level 14 pin ww .21

CONNECTORS	
44 pin edge	2.00
100 pin edge	4.50
100 pin edge WW	5.25
MOS/MEMORY RAM	
2101-1	3.95
2102-1	1.28
2102AL-4	1.60
21F02	1.85

2104A-4	4.95
2107B	4.95
2111-1	4.95
2112-2	3.95
2114	8.50
MK4116	27.50
2513B	6.30
21L02-1	1.49
MM5262	.40
MM5280	3.00
MM5320	9.95
MM5330	5.94
PD411D-3	4.00
PD411D-4	5.00
P5101	13.95
4200A	12.95
82S25	2.90
91L02A	1.75
HD0165-5	6.95
MM57100	4.50
GIAY38500-1	9.95
MCM6571A	10.95
9368	3.50
INTERFACE	
8T26	1.69
8T28	2.75
8T97	1.69

CRYSTALS

1 MHz	4.50	2.0100 MHz	1.95
2 MHz	4.50	2.097152 MHz	4.50
4 MHz	4.25	2.4576 MHz	4.50
5 MHz	4.25	3.2768 MHz	4.50
10 MHz	4.25	5.0688 MHz	4.50
18 MHz	3.90	5.185 MHz	4.50
20 MHz	3.90	5.7143 MHz	4.50
32 MHz	3.90	6.5536 MHz	4.50
32768 Hz	4.00	14.31818 MHz	4.25
1.8432 MHz	4.50	18.432 MHz	4.50
3.5795 MHz	1.20	22.1184 MHz	4.50

60 Hz Crystal Time Base Kit	**$ 4.40**
30 MHz Frequency Counter Kit	**$47.75**
Prescaler Kit to 350 MHz	**$19.95**
COMPUTER BOARD KITS	
8K RAM Board Kit	$134.95
4K EPROM Kit	114.95
I/O Board Kit	44.50
Extender Board w/connector	12.50
Video Interface board kit	125.00
16K EPROM board kit w/o PROMS	74.50
16K Static RAM board kit	395.00
North Star Floppy Disk Kit	$665.00
Additional Drive Kit	415.00
Paratronics 100A Logic Analyzer Kit	**$199.00**
Model 10 Trigger Expander Kit	$229.00
Model 150 Bus Grabber Kit	$369.00

New Cosmac Super "ELF"

RCA CMOS expandable to 64K microcomputer w/HEX keypad input and video output for graphics. Just turn on and start loading your program using the resident **monitor on ROM**. Pushbutton selection of all four CPU modes. LED indicators of current CPU mode and four CPU states. Single step op. for program debug. Built in pwr. supply, 256 Bytes of RAM, audio amp. & spkr. Detailed assy. man. w/PC board & all parts fully socketed. Comp. Kit **$106.95**. High address display option **8.95**; Low address display option **9.95**; Custom hardwood cab.; drilled front panel **19.75**; Nicad Battery Backup Kit w/all parts **4.95**; Fully wired & tested in cabinet **151.70**; 1802 software club. 10–12 pg. monthly publication **12.00** per yr.

4K Elf Expansion Board Kit with Cassette I/F — $79.95

Available on board options: 1K super ROM monitor **$19.95**. Parallel I/O port **$7.95**. RS232 I/F **$3.50**. TTY 20 ma I/F **$1.95**. S-100 Memory I/F **$4.50**.

Tiny Basic for ANY 1802 System

Cassette **$10.00**
on ROM Monitor **$38.00**
Super Elf owners take 30% off.
Object code listing or paper tape with manual **$5.50**

Auto Clock Kit — $15.95

DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add **$3.95** for beautiful dark gray case. Best value anywhere.

'78 IC Update Master Manual

1978 IC Update Master Manual **$30.00**
Complete IC data selector 2175 pg. Master reference guide. Over 42,000 cross references. Free update service through 1978. Domestic postage $3.50. Foreign $6.00. Final 1977 Master closeout **$15.00**

Video Modulator Kit — $8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

RCA CosmacVIP Kit — $275.00

Video computer with games and graphics.

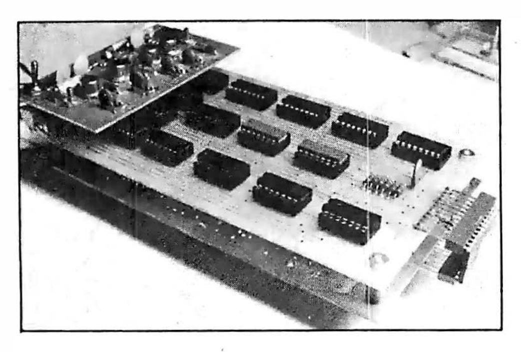
Sinclair 3½ Digit Multimeter

Batt. oper. 1mV and .1NA resolution. Resistance to 20 meg. 1% accuracy. Small, portable, completely assem. in case. 1 yr. guarantee. **$59.95**

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax. BankAmericard and Master Charge accepted. Shipping charges will be added on charge cards.
FREE: Send for your copy of our NEW 1978 QUEST CATALOG. Include 24¢ stamp.

Circle 307 on inquiry card.

A Video Camera Kit





This 202 video camera kit may be used for visible or infrared viewing and surveillance with an infrared light source, and is excellent for standard surveillance work because of its light weight (under one pound) and small size (3¾ by 6½ inch boards). A 5 V, 1 A power supply is needed. The kit includes all semiconductors, boards, data sheets, diagrams, resistors, capacitors, and an 8 mm lens. The kit sells for $349 from Solid State Sales, POB 74B, Somerville, MA 02143.■

Circle 615 on inquiry card.

Video Terminal Offered by Phone 1



The new model P1-11 video terminal features the following: 80 by 24 screen, local editing, upper and lower case display, dual screen intensity, full or half duplex operation, numeric cluster keyboard, and 300 bps acoustical modem. The unit sells for $1075 complete and $800 for the terminal alone. Contact Phone 1 Inc, 1330 E State St, Rockford IL 61108.■

Circle 616 on inquiry card.

Module Interfaces Voice and Instruments to Synthesizers



The Aries AR-333 pitch and envelope follower is an electronic module that interfaces external signal sources, such as voice, single note instruments, and tape recorders, to most synthesizers. A one octave change of input signal produces a 1 V change in pitch control output for controlling VC oscillator frequency, filter frequency, etc. Linear and logarithmic envelope follower outputs allow control of synthesizer functions by the amplitude of the input signal. On the front panel, a trim pot lets you adjust the tracking sensitivity of the pitch control output, and permits use of the module with different synthesizers without retrimming oscillators. The front panel also provides a tuning control for adjusting oscillator frequency which allows tuning to the pitch of other instruments, and a retriggering sensitivity control for picking up accents. A low distortion compressor output is also provided. The module's 36 db, low noise microphone preamp accepts ¼ inch phone plugs. It sells for $349 (kit) and $499 (assembled). An assembled AR-333 with case and power supply (Model GE-101) sells for $550. Contact Aries Music Inc, Shetland Industrial Park, POB 3065, Salem MA 01970.■

Circle 618 on inquiry card.

Isolated Digital Output Board for Intel Microcomputers



Plug compatible 16 or 32 channel isolated digital output systems are available for the Intel SBC 80 and Intellec MDS microcomputers. Isolation eliminates ground loop problems and protects the processor from real world transients. Memory mapped MP801 (16 channel) or MP802 (32 channel) systems are contained on a single printed circuit board and provide all control and timing circuitry. Channels are implemented by dry reed relays protected by metal oxide varistors and can handle up to 10 W. Relays provide low "on-impedance," high output current and isolate output channels from the computer bus (to 600 VDC) and from channel to channel (300 VDC). They are treated as memory by the processor, eight output channels occupying one memory location. Prices of the 16 channel MP801 are $295 and $475 for the 32 channel MP802 in quantities of one to nine. Contact Burr-Brown, International Airport Industrial Park, Tucson AZ 85734.■

Circle 617 on inquiry card.

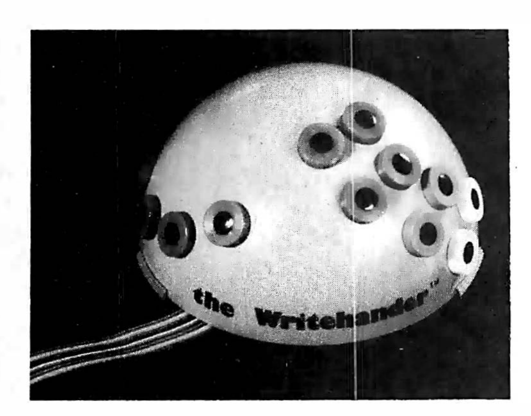
Attention Readers, and Vendors. . .

Where Do New Product Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the neat new whiz-bang gizmo or save the world software package is of interest to the personal computing experimenters and homebrewers who read BYTE, we print the information in some form. We openly solicit such information from manufacturers and suppliers to this marketplace. The information is printed more or less as a first in first out queue, subject to occasional priority modifications.

Circle 130 on inquiry card.

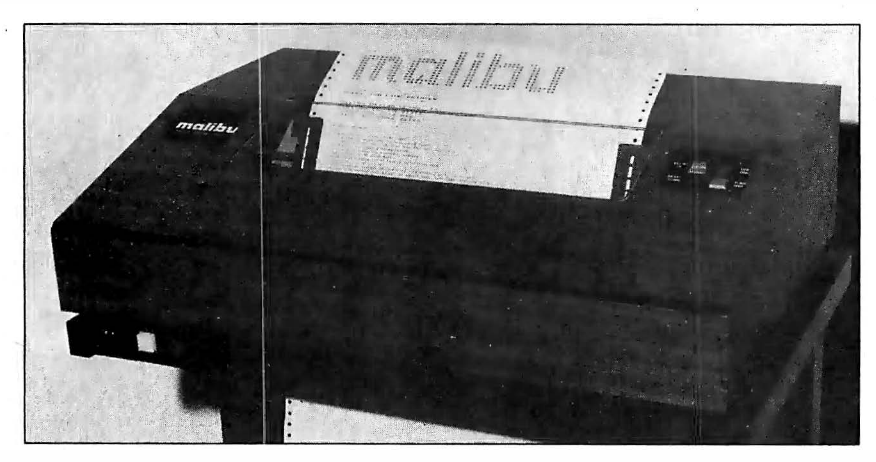
The Writehander: a New Typing Keyboard for One Hand



A typing keyboard has been designed that permits typing all 128 characters of the ASCII code with one hand and is particularly useful with computers and terminals that accept ASCII coded parallel input. To use the Writehander, the typist places four fingers on four press switches and the thumb on one of eight press switches. The four finger switches operate as the lower four bits of the 7 bit ASCII code, selecting the group of characters (out of 16 groups) that contains the desired character. The group contains a choice of eight letters, numerals, symbols, etc. The thumb then presses the particular switch that selects the desired character from the choice of eight. A computer is not required to operate the terminal. The Writehander will directly operate terminals such as the Diablo HyType, Teletype ASCII modified Selectric, or a video monitor that accepts parallel 7 bit ASCII signals. Required power is 200 mADC from 5 V regulated or 7 to 25 V unregulated. The unit connects to the terminal through a ribbon cable that has lines for the 7 bit ASCII code, a 1 bit fixed parity, strobe and acknowledge signals and the power and common lines. The price of the Writehander is $98 and it can be obtained from the NewO Company, 246 Walter Hays Dr, Palo Alto CA 94303.■

Circle 646 on inquiry card.

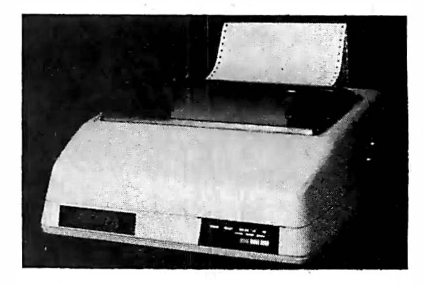
Line Printer with Graphic Capabilities



The Model 160 Malibu Line Printer is a commercial grade dot matrix machine which operates bidirectionally at 165 characters per second and has graphics capabilities. The printer's features include logic seeking capabilities for fast throughput, reinking rollers (said to increase ribbon life up to 50 million characters), and jumper selectable primary voltage (110 to 220 V, 50 to 60 Hz). Standard software supports the 96 character ASCII set, but the user may easily change the characters to exotic languages, scientific symbols, or whatever can be printed with a 9 pin head. The tractor operated paper feed allows groups of dots to be placed immediately adjacent to one another either horizontally or vertically, giving graphics capabilities at 3000 dot locations per square inch. The Malibu accepts paper from 4 inch (10 cm) to 15 (37.5 cm) inch width and prints up to 132 characters per line. Normal line feed is 1/6 inch (0.4 cm), but increments of 1/60 inch (0.04 cm) are possible under software control. All circuitry is designed into three circuit boards which plug into the mother board. An optional Altair (S-100) interface card is available, making the printer immediately operable with many popular computers. An RS-232 option with a Z-80 processor on board allows the printer to accept serial input (up to 9600 bps) or parallel ASCII input with handshaking. The Malibu printer is priced at less than $2000 from Malibu Design Group Inc, 21110G Nordhoff St, Chatsworth CA 91311.■

Circle 653 on inquiry card.

Full Character Line Printer

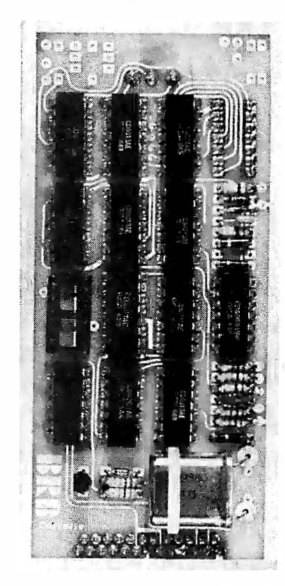


The FUTRA Model 10 Line Printer incorporates a belt impact, full character (not dot matrix) 80 column printing mechanism. The unit operates at a minimum print rate of 150 lines per minute using the 64 ASCII character set or a minimum of 84 lines per minute using a full 96 ASCII character set and can produce up to four copies including the original. The input is an 8 bit parallel which can be interfaced to a 3P+S or similar interface card. The unit has a buffer size of one full line (80 characters) and a maximum data input rate of 75,000 characters per second.

The Model 10 is priced at $2695 and comes with pin feed paper handling mechanism, format control unit (top of form), either 64 or 96 ASCII character set and parallel interface. Options are an off line test print excercisor, $75; and serial interface (RS-232c, 20 mA current loop, TTL direct interface with 1010 byte buffer), $595. Contact FUTRA, 3421 Onyx St, POB 4380, Torrance CA 90510, (213) 371-8138.■

Circle 583 on inquiry card.

Fast Cassette Interface



The Wince Cassette Interface dumps and loads programs at a data rate of 2400 bps. It also supports the 300 bps Kansas City standard. The unit interfaces directly to a Motorola 6850 ACIA and includes an RS232 interface at data rates from 150 to 9600 bps. The interface board is priced at $139 in single quantities from Wintek Corp, 902 N 9th St, Lafayette IN 47904, (317) 742-6802.■

Circle 584 on inquiry card.

SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

DIP JUMPERS



Mates with standard IC sockets
24" length • Fully Assembled & Tested

# CONTS	DESCRIPTION	PART NO.	PRICE
14	sgl. end	924-102-24	$ 1.92
14	dbl. end	924106-24	3.02
16	sgl. end	924112-24	2.13
16	dbl. end	924116-24	3.34
24	sgl. end	924122-24	3.30
24	dbl. end	924126-24	5.20
40	sgl. end	924132-24	5.53

Also Available in 12" and 36" lengths

CRYSTALS

THESE FREQUENCIES ONLY

PART NO.	FREQUENCY	CASE	PRICE
CY1A	1.000MHz	HC33	5.95
CY1.84	1.8432MHz	HC33	5.95
CY2A	2.000MHz	HC33	5.95
CY2.01	2.010MHz	HC33	1.95
CY2.50	2.500MHz	HC33	4.95
CY3.27	3.2768MHz	HC33	4.95
CY3.57	3.579545MHz	HC33	4.95
CY3A	4.000MHz	HC18	4.95
CY4.91	4.916MHz	HC18	4.95
CY7A	5.000MHz	HC18	4.95
CY5.18	5.185MHz	HC18	4.95
CY6.14	6.144MHz	HC18	4.95
CY6.40	6.400MHz	HC18	4.95
CY6.55	6.5536MHz	HC18	4.95
CY12A	10.000MHz	HC18	4.95
CY14A	14.31818MHz	HC18	4.95
CY19A	18.000MHz	HC18	4.95
CY18.43	18.432MHz	HC18	4.95
CY22A	20.000MHz	HC18	4.95
CY30A	32.000MHz	HC18	4.95

TRIMMERS

10MM size trimmers -.394" Dia.

Part No.	1-9	10-24	25-49	100+
TR-11(valve)	.35	.30	.25	20

Resistance values - 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1 meg

TRIMPOTS

Single-Turn - 1/2 Watt
Square - Top Adjust - 3/8" Size

Part No.	1-9	10-24	25-49	50-99
63P(value)	.99	.89	.80	.70

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg.

15-Turn - 3/4 Watt
Rectangular Side Adjust 3/4" x 1/4" Size

Part No.	1-9	10-24	25-49	50-99
43P(value)	1.35	1.25	1.20	1.15

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg.

1/16 VECTOR BOARD

	0.1" Hole Spacing Part No	P-Pattern L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12



SLIT-N-WRAP

Model P180 includes 2-100' spools #28 AWG wire wrap wire

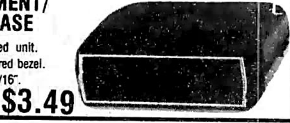
Supplies insulated wire from spool to wrap-posts without prestripping and precutting using "daisy chain" method.

Model P180 $24.50

REPLACEMENT WRAP BIT for P180 Slit N Wrap No. P180A $12.95 each

Replacement wire-wrap wire for P180 #28 AWG (pkg. of 3) $2.75 each
W28-2-A green W28-2-B red
W28-2-C clear W28-2-D blue

INSTRUMENT/ CLOCK CASE



Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".

$3.49

MICROPROCESSOR COMPONENTS

Part	Description	Price	Part	Description	Price
P8085	CPU	$29.95	CDP 1802	CPU	$19.95
8080A	CPU	10.95	Z80	CPU	24.95
8212	8-Bit Input/Output	4.95	2650	MPU	26.50
8214	Priority Interrupt Control	7.95	MC6800	MPU	19.95
8216	Bi-Directional Bus Driver	4.95	MC6810API	128 x 8 Static Ram	5.95
8224	Clock Generator/Driver	5.95	MC6820	Periph. Interface Adapter	7.95
8228	System Controller/Bus Driver	5.95	MC6821	Periph. Interface Adapter	11.50
8251	Prog. Comm. Interface	9.95	MC6830L8	1024 x 8 Bit ROM	14.95
8255	Prog. Periph. Interface	10.95	MC6850	Asychronous Comm. Adapter	14.95

RAM'S

1101	256 x 1	Static	$ 1.49
1103	1024 x 1	Dynamic	.99
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107/5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
2112	256 x 4	Static	5.95
2114	4K x 1	Static 450ns	9.95
2114L	4K x 1	Static 450ns Low Power	10.95
2114-3	4K x 1	Static 300ns	10.95
2114L-3	4K x 1	Static 300ns Low Power	11.95
7489	16 x 4	Static	1.75
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
21L02	1024 x 1	Static	1.95
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	3/1.00
MK4027 (UPD414)	4K	DYNAMIC 16 PIN	5.95
MK4116 (UPD416)	16K	DYNAMIC 16 PIN	29.95
TMS4044-45NL	4K	STATIC	14.95

ROM'S

2513(2140)	Character Generator (upper case)	$ 9.95
2513(3021)	Character Generator (lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048 Bit Read Only Memory	1.95

USER MANUALS

1802M	CDP1802 Manual	$ 7.50
Z80M	Z80 Manual	7.50
2650M	2650 Manual	5.00

PROMS

1702A	2048 x 1	Famous	$ 5.95
5203	2048 x 1	Famous	14.95
82S23	32 x 8	Open C	5.00
82S115	4096 x 1	Bipolar	19.95
82S123	32 x 6	Tristate	5.00
74S287	1024 x 1	Static	7.95
2708	8K	EPROM	10.95
2716 T.I.	16K	EPROM	29.95
2716 Intel	16K	EPROM	59.95
6301-1	1024 x 1	Tri-State Bipolar	3.49
6330-1	256 x 1	Open C Bipolar	2.95
74186	512 x 1	TTL Open Collector	9.95
74188	256 x 1	TTL Open Collector	3.95

SHIFT REGISTERS

MM5013N	1024 BitAccumulator Dynamic	2.95
MM5016H	500/512 Bit Dynamic	.89
MM5017N	Dual 500/512 Bit Dynamic	2.95
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2519	Hex 40 Bit Static	4.00
2522	Dual 132 Bit Static	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4 X 4 Register	1.95

UART'S

AY-5-1013	30K BAUD	$ 5.95

SPECIAL REQUESTED ITEMS

TELEPHONE KEYBOARD CHIPS

AY-5-9100	$14.95
AY-5-9200	14.95
AY-5-9500	4.95
AY-5-2376	14.95
HD0165	7.95
74C922	9.95

ICM CHIPS

ICM7045	$24.95
ICM7205	19.95
ICM7207	7.50
ICM7208	19.95
ICM7209	6.95

NMOS READ ONLY MEMORIES

MCM6571	$13.50
MCM6574	13.50
MCM6575	13.50

TV GAME CHIP SET
AY-3-8500-1 Chip and 2.010 MH2 Crystal $7.95

MISCELLANEOUS

11C90	$19.95	MK40240	$17.50
MC3061P	11.95	DS0026CH	3.75
MC1408L7	4.95	[illegible]	10.20
MC1408L8	5.75	95H90	11.95
LD110/111	$25.00/set		
MC4016(74416)	7.50		
4N33	3.95		

PARATRONICS

Logic Analyzer Kit Model 100A

$229.00/kit

Model 100A Model 10

- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4 95)

- Some applications are:
  - — Troubleshooting microprocessor address, instruction, and data flow
  - — Examine contents of ROMS
  - — Tracing operation of control logic
  - — Checking counter and shift register operation
  - — Monitoring I/O sequences
  - — Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit).

Model 10 Kit - $229.00
Baseplate — $9.95
Model 10 Manual — $4.95

B+K PRECISION

3½-Digit Portable DMM



- Overload Protected
- 3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv 1Va 0 1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage - 0-1000V
AC Voltage 0-1000V
Freq Response 50-400 hZ
DC/AC Current: 0-100mA
Resistance 0-10 meg ohm
Size 6 4" x 4 4" x 2"

Model 2800 $99.95

Comes with test leads operating manual and spare fuse

Accessories:

AC Adapter BC-28 $9.00
Rechargeable Batteries BP-26 20.00
Carrying Case LC-28 7.50

CSC

100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1 75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95



ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator
use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator
use 110 V AC — Model 100 — CAI $9.95

KEYBOARDS

63-Key Unencoded



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Encoder



19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax

Spec Sheets – 25¢
1978A Catalog Available–Send 35¢ stamp





PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru July

The Incredible "Pennywhistle 103"



$129.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf. In addition, it is free of critical adjustments and is built with non-precision readily available parts

Data Transmission Method .....Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate..........300 Baud
Data Format................Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies...2025 Hz for space; 2225 Hz for mark
Transmit Channel Frequencies..Switch selectable: Low (normal) 1070 space, 1270 mark; High 025 space 225 mark
Receive Sensitivity........... 46 dbm accoustically coupled
Transmit Level............... 15 dbm nominal. Adjustable from 6 dbm to 20 dbm
Receive Frequency Tolerance...Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface.........EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements..........120 VAC single phase, 10 Watts
Physical.....................All components mount on a single 5 by 9 printed circuit board. All components included
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

The Original the 3rd Hand

$9.95 each



- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59 59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One
  Times Single Event — Split & Taylor
- Size 4 5 x 2 15 x 90 (4½ ounces)
- Uses 3 Penlite Cells



Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

IMC 3½ DIGIT DPM KIT



- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model KB503 5V Power Kit $17.50

JE700 CLOCK



The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip

12 or 24 Hour

115 VAC *KIT ONLY* **$16.95**

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (H) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result



$9.95 Per Kit

printed circuit board

T²L 5V 1A Supply



This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **JE225 $9.95 Per Kit**

CSC PROTO BOARDS

PROTO BOARD 6
$15.95
(6" long X 4" wide)

PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	129.95

PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

7400 TTL

SN7400N	.16				
SN7401N	.18	SN7472N	.29	SN74160N	.89
SN7402N	.18	SN7473N	.35	SN74161N	.89
SN7403N	.18	SN7474N	.35	SN74162N	1.95
SN7404N	.18	SN7475N	.49	SN74163N	.89
SN7405N	.20	SN7476N	.35	SN74164N	.89
SN7406N	.29	SN7479N	5.00	SN74165N	.89
SN7407N	.29	SN7480N	.50	SN74166N	1.25
SN7408N	.20	SN7482N	.99	SN74167N	1.95
SN7409N	.20	SN7483N	.59	SN74170N	1.59
SN7410N	.18	SN7485N	.79	SN74172N	6.00
SN7411N	.25	SN7486N	.35	SN74173N	1.25
SN7412N	.25	SN7489N	1.75	SN74174N	.89
SN7413N	.40	SN7490N	.45	SN74175N	.79
SN7414N	.70	SN7491N	.59	SN74176N	.79
SN7416N	.25	SN7492N	.43	SN74177N	.79
SN7417N	.25	SN7493N	.43	SN74179N	1.95
SN7420N	.20	SN7494N	.65	SN74180N	.79
SN7421N	.29	SN7495N	.65	SN74181N	1.95
SN7422N	.39	SN7496N	.65	SN74182N	.79
SN7423N	.25	SN7497N	3.00	SN74184N	1.95
SN7425N	.29	SN74100N	.89	SN74185N	1.95
SN7426N	.29	SN74107N	.35	SN74186N	9.95
SN7427N	.25	SN74109N	.59	SN74188N	3.95
SN7429N	.39	SN74116N	1.95	SN74190N	1.25
SN7430N	.20	SN74121N	.35	SN74191N	1.25
SN7432N	.25	SN74122N	.39	SN74192N	.79
SN7437N	.25	SN74123N	.49	SN74193N	.79
SN7438N	.25	SN74125N	.49	SN74194N	.89
SN7439N	.25	SN74126N	.49	SN74195N	.69
SN7440N	.20	SN74132N	.75	SN74196N	.89
SN7441N	.89	SN74136N	.75	SN74197N	.89
SN7442N	.49	SN74141N	.79	SN74198N	1.49
SN7443N	.75	SN74142N	2.95	SN74199N	1.49
SN7444N	.75	SN74143N	2.85	SN74200N	5.59
SN7445N	.75	SN74144N	2.95	SN74251N	1.79
SN7446N	.69	SN74145N	.79	SN74279N	.79
SN7447N	.59	SN74147N	1.95	SN74283N	2.25
SN7448N	.79	SN74148N	1.29	SN74284N	3.95
SN7450N	.20	SN74150N	.89	SN74285N	3.95
SN7451N	.20	SN74151N	.59	SN74365N	.69
SN7453N	.20	SN74153N	.59	SN74366N	.69
SN7454N	.20	SN74154N	.99	SN74367N	.69
SN7459A	.25	SN74155N	.79	SN74368N	.69
SN7460N	.20	SN74156N	.79	SN74390N	1.95
SN7470N	.29	SN74157N	.65	SN74393N	1.95

C/MOS

CD4000	.23			CD4070	.55
CD4001	.23			CD4071	.23
CD4002	.23	CD4028	.89	CD4072	.49
CD4006	1.19	CD4029	1.19	CD4076	1.39
CD4007	.25	CD4030	.49	CD4081	.23
CD4009	.49	CD4035	.99	CD4082	.23
CD4010	.49	CD4040	1.19	CD4093	.99
CD4011	.23	CD4041	1.25	CD4098	2.49
CD4012	.25	CD4042	.99	MC14409	14.95
CD4013	.39	CD4043	.89	MC14410	14.95
CD4014	1.39	CD4044	.89	MC14411	14.95
CD4015	1.19	CD4046	1.79	MC14419	4.95
CD4016	.49	CD4047	2.50	MC14433	19.95
CD4017	1.19	CD4048	1.35	MC14506	.75
CD4018	.99	CD4049	.49	MC14507	.99
CD4019	.49	CD4050	.49	MC14562	14.50
CD4020	1.19	CD4051	1.19	MC14583	3.50
CD4021	1.39	CD4053	1.19	CD4508	3.95
CD4022	1.19	CD4056	2.95	CD4510	1.39
CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	1.25	CD4068	.39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	3.00
74C02	.55			74C164	3.25
74C04	.75	74C89	6.49	74C173	2.60
74C08	.75	74C90	3.00	74C192	3.49
74C10	.65	74C93	3.00	74C193	2.75
74C14	3.00	74C95	2.00	74C195	2.75
74C20	.65	74C107	1.25	74C922	9.95
74C30	.65	74C151	2.90	74C923	8.95
74C42	2.15	74C154	3.00	74C925	14.95
74C48	4.75	74C157	2.15	74C926	11.95
74C73	1.50	74C160	3.25	80C95	1.50
74C74	1.15	74C161	3.25	80C97	1.50

LINEAR

78MG	1.75			LM733N	1.00
LM300H	.80			LM739N	1.19
LM301H	.35			LM741CH	.35
LM301CN	.35	LM340T-8	1.25	LM741CN	.35
LM302H	.75	LM340T-12	1.25	LM741-14N	.39
LM304H	1.00	LM340T-15	1.25	LM747H	.79
LM305H	.60	LM340T-18	1.25	LM747N	.79
LM307CN/H	.35	LM340T-24	1.25	LM748H	.39
LM308H	1.00	LM350N	1.00	LM748N	.39
LM308CN	1.00	LM351CN	.65	LM1303N	.90
LM309H	1.10	LM370N	1.15	LM1304N	1.19
LM309K	1.25	LM373N	3.25	LM1305N	1.40
LM310CN	1.15	LM377N	4.00	LM1307N	.85
LM311H	.90	LM380N	1.25	LM1310N	2.95
LM311N	.90	LM380CN	.99	LM1351N	1.65
LM317K	6.50	LM381N	1.79	LM1414N	1.75
LM318CN	1.50	LM382N	1.79	LM1458CN/H	.59
LM319N	1.30	NE501N	8.00	MC1488	1.95
LM320K-5	1.35	NE510A	8.00	MC1489	1.95
LM320K-5.2	1.35	NE529A	4.95	LM1496N	.95
LM320K-12	1.35	NE531H	3.00	LM1556V	1.75
LM320K-15	1.35	NE536T	6.00	MC1741SCP	3.00
LM320K-18	1.35	NE540L	6.00	LM2901N	2.95
LM320K-24	1.35	NE550N	1.30	LM3053	1.50
LM320T-5	1.25	NE555V	.39	LM3065N	.69
LM320T-5.2	1.25	NE556	.99	LM3900N(3401)	.49
LM320T-8	1.25	NE560B	5.00	LM3905N	.89
LM320T-12	1.25	NE561B	5.00	LM3909	1.25
LM320T-15	1.25	NE562B	5.00	MC5558V	1.00
LM320T-18	1.25	NE565H	1.75	LM7525N	.90
LM320T-24	1.25	NE565N	1.25	LM7534N	.75
LM323K-5	5.95	NE566CN	1.75	8038B	4.95
LM324N	1.80	NE567H	1.25	LM75450	.49
LM339N	.99	NE567V	.99	75451CN	.39
LM340K-5	1.35	NE570	10.50	75452CN	.39
LM340K-6	1.35	LM703CN/H	.45	75453CN	.39
LM340K-8	1.35	LM709H	.29	75454CN	.39
LM340K-12	1.35	LM709N	.29	75491CN	.79
LM340K-15	1.35	LM710N	.79	75492CN	.89
LM340K-18	1.35	LM711N	.39	75494CN	.89
LM340K-24	1.35	LM723H	.55	RC4151	5.95
LM340T-5	1.25	LM723N	.55	RC4194	5.95
LM340T-6	1.25			RC4195	4.49

74LS00 TTL

74LS00	.23			74LS155	.69
74LS02	.23			74LS157	.69
74LS03	.23	74LS74	.35	74LS160	.89
74LS04	.29	74LS75	.49	74LS161	.89
74LS05	.29	74LS76	.35	74LS162	.89
74LS08	.23	74LS83	.75	74LS163	.89
74LS10	.23	74LS85	.99	74LS164	.89
74LS13	.49	74LS86	.35	74LS175	.79
74LS14	.99	74LS90	.49	74LS181	2.49
74LS20	.23	74LS92	.59	74LS190	.89
74LS26	.29	74LS93	.59	74LS191	.89
74LS27	.29	74LS95	.79	74LS192	.89
74LS28	.29	74LS96	.89	74LS193	.89
74LS30	.23	74LS107	.35	74LS194	.89
74LS32	.29	74LS109	.35	74LS195	.89
74LS40	.29	74LS112	.35	74LS253	.79
74LS42	.69	74LS123	.99	74LS257	.69
74LS47	.69	74LS132	.79	74LS260	.55
74LS51	.23	74LS136	.39	74LS279	.59
74LS55	.23	74LS138	.69	74LS367	.59
74LS73	.35	74LS139	.69	74LS368	.59
		74LS151	.69	74LS670	1.95

BUGBOOK®

Continuing Education Series

BUGBOOKS I and II — $17.00 per set
by Peter R. Rony, David G. Larsen, WB4HYJ
Sold as a set these two books outline over 90 experiments designed to teach the reader all he will need to know about TTL logic chips to use them in conjunction with microprocessor systems. You'll learn about the basic concepts of digital electronics including gates, flip-flops, latches, buses, decoders, multiplexers, demultiplexers, LED displays, RAM's, ROM's, and much, much more.

BUGBOOK IIa — $5.00
by Peter R. Rony, David G. Larsen, WB4HYJ
This volume will introduce you to the fabulous UART chip — that all important interface between data terminals, etc., and your microcomputer. It also covers current loops, and the RS 232C interface standard. Particularly recommended for any RTTY enthusiast.

THE 555 TIMER APPLICATIONS SOURCEBOOK WITH EXPERIMENTS — $6.95
by Howard M. Berlin W3HB
This book shows you what the 555 timer is and how to use it. Included are over 100 various design techniques, equations and graphs to create "ready-to-go" timers, generators, power supplies, measurement and control circuits, party games, circuits for the home and automobile, photography, music and Amateur Radio.

INSTRUCTOR'S MANUAL — $3.00
Necessary for instruction of Bugbook I and II. Answers questions regarding experiments, suggestions for further reading, philosophy of authors approach to digital electronics. A must for self-teaching individuals.

OP AMP MANUAL by Howard M. Berlin W3HB — $9.00
An experiment guide to application of operational amplifiers. Over 25 experiments on all phases of Op Amps.

DBUG — $5.00
8080 interpretive debugger. A program for entering, debugging and storing assembly language programs.

BUGBOOK III — $15.00
by Peter R. Rony, David G. Larsen, WB4HYJ, Jonathan A. Titus
Here is the book that puts it all together. Besides having much valuable text there are a series of experiments in which the reader completely explores the 8080 chip pin by pin and introduces you to the Mark 80 microcomputer, a unique easily interfaced system. It is recommended that you have the background on the BUGBOOKS I & II before proceeding with BUGBOOK III.

BUGBOOK V and VI — $19.00 per set
by David G. Larsen, Peter R. Rony, Jonathan A. Titus
Experiments in digital electronics, 8080A microcomputer programming and 8080A microcomputer interfacing. An integrated approach to self-instructed basic digital electronics, breadboarding and 8080A interfacing/programming. Bugbook VI integrates the digital concepts of Bugbook V into a treatment of 8080A microcomputer programming and interfacing. Detail & laboratory experiments included with each book.

CMOS-M — DESIGNERS PRIMER AND HANDBOOK New expanded version — $8.50
Starts at basic structure of CMOS devices through integration into MSI.

COMPLETE MANUAL FOR DIGITAL CLOCKS by John Weiss and John Brooks
Familiarizes technician or hobbyist with basic theories behind digital clocks. Includes trouble shooting guides, basic characteristics of clocks, soldering techniques, clock component data sheets and construction tips. — $3.95

DISCRETE LEDS

.125" dia.		
XC209	Red	5/$1
XC209	Green	4/$1
XC209	Orange	4/$1
XC209	Yellow	4/$1

.200" dia		
XC22	Red	5/$1
XC22	Green	4/$1
XC22	Yellow	4/$1
XC22	Orange	4/$1
SSL-22	RT	4/$1

.185" dia.		
XC526	Red	5/$1
XC526	Red	100/$8
XC526	Green	4/$1
XC526	Yellow	4/$1
XC526	Clear	4/$1

.200" dia.		
XC556	Red	5/$1
XC556	Red	100/$8
XC556	Green	4/$1
XC556	Yellow	4/$1
XC556	Orange	4/$1
XC556	Clear	7/$1

.190" dia.		
XC111	Red	5/$1
XC111	Green	4/$1
XC111	Yellow	4/$1
XC111	Orange	4/$1

.085" dia. MV50 - Red - 6/$1
.170" dia. MV10 Red - 4/$1

INFRA-RED LED ¼" x ¼" x 1/16" Flat 5/$1.00

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6680	Common Cathode-orange	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6710	Common Anode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6730	Common Anode-red ±1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 52	Common Anode-green	.300	1.25	MAN 6750	Common Cathode-red ±1	.560	.99
MAN 71	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	.99
MAN 72	Common Anode-red	.300	.99	MAN 6780	Common Cathode-red	.560	.99
MAN 74	Common Cathode-red	.300	1.25	DL701	Common Anode-red ±1	.300	.99
MAN 81	Common Anode-yellow	.300	.99	DL702	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.99	DL707	Common Anode-red	.300	.99
MAN 3620	Common Anode-orange	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3630	Common Anode-orange ±1	.300	.99	DL746	Common Anode-red ±1	.630	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 4610	Common Anode-orange	.300	.99	DL749	Common Cathode-red ±1	.630	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL750	Common Cathode-red	.600	1.49
MAN 4710	Common Anode-red ±1	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4730	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Anode	.350	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode (FND500)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6630	Common Anode-orange	.560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6640	Common Cathode-orange-D.D.	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6650	Common Cathode-orange ±1	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6660	Common Anode-orange	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA2023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3130	1.39
CA3059	3.25	CA3140	1.25
CA3060	3.25	CA3160	1.25
CA3080	.85	CA3401	.49
CA3081	2.00	CA3600	3.50

CALCULATOR CHIPS AND DRIVER

FCM3817	$5.00
MM5725	2.95
MM5736	1.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
5030	7.95

CLOCK CHIPS

MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
7001	5.95

9374 - 7-segment LED driver common anode LEDs $ .99

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$.37	.35	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$.27	.25	.24	28 pin ST	$.99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	.27	.24	24 pin SG	$.70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.75	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$.40	.38	.35	22 pin WW	.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	1/4 WATT 5% 50 PCS.
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	1/4 WATT 5% 50 PCS.
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	1/4 WATT 5% 50 PCS.
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	1/4 WATT 5% 50 PCS.
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	1/4 WATT 5% 50 PCS.
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	1/4 WATT 5% 50 PCS.
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	1/4 WATT 5% 50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets — 25¢
1978A Catalog Available — Send 35¢ stamp

NEW NAME

Jameco ELECTRONICS
a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru July

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

$12.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $6.95

WIRE WRAP WIRE — 30 AWG

25ft. min. $1.25 50ft. $1.95 100ft. $2.95 1000ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.95 ea.**
- Cuts wire to desired length
- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

REPLACEMENT DISPENSER SPOOLS FOR WD 30
Specify blue, yellow, white or red **$1.98/spool**

EXAR

XR2206KA $14.95 Function Generator Kit (includes chip, P.C. Board and instructions)

XR2206KB $19.95 Function Generator Kit (includes all components, P.C. Board and instructions)

XR-L555 $1.50
Micro-Power version of the popular 555 Timer and directly interchangeable. Dissipates 1/15th the power and operates down to 2.7 volts. Perfect for battery operation and CMOS circuits.

XR2242CP $1.50
Precision timing circuit for generating timing pulses in **minutes, hours** and days or up to 1 year by using two. Reduces cost of time delay circuits. Basic 555 Timer with built-in 8-bit Counter.

XR205	$8.40	XR1489	1.39	XR2556	$3.20
XR210	4.40	XR1800	3.20	XR2567	2.99
XR215	4.40	XR2206	4.40	XR3403	1.25
XR320	1.55	XR2207	3.85	XR4136	1.25
XR555	.39	XR2208	5.20	XR4151	2.85
XR556	.99	XR2209	1.75	XR4194	1.45
XR567CP	.99	XR2211	5.25	XR4202	3.60
XR567CT	1.25	XR2212	4.35	XR4212	2.05
XR1310P	1.30	XR2240	3.45	XR4558	.75
XR1468CN	3.85	XR2264	4.25	XR4739	1.15
XR1488	1.39			XR4741	1.47

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
TIS133	5/1.00	PN3567	3/1.00	PN4249	4/1.00
TIS135	5/1.00	PN3568	4/1.00	PN4250	4/1.00
40409	1.75	PN3569	4/1.00	2N4400	4/1.00
40410	1.75	MPS3638A	5/1.00	2N4401	4/1.00
40673	1.75	MPS3702	5/1.00	2N4402	4/1.00
2N918	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2219A	3/1.00	MPS3704	5/1.00	2N4409	5/1.00
2N2221A	4/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2222A	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2906	4/1.00	2N3724A	.65	PN5138	5/1.00
2N2907	5/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	4/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.26
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

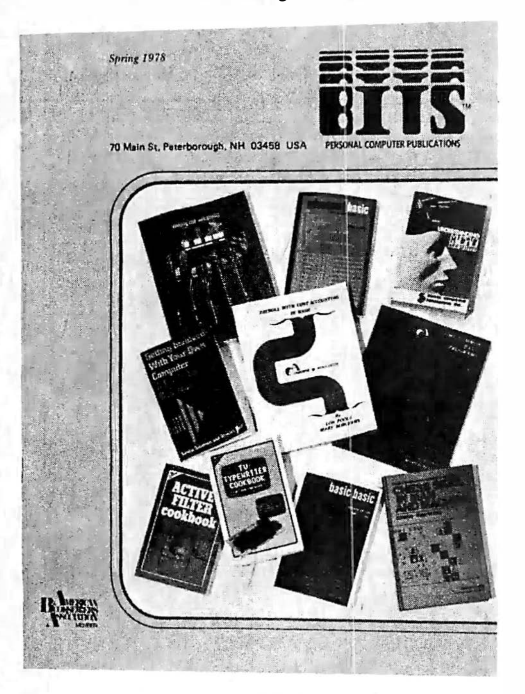
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-99	100+	Radial Lead	1-9	10-99	100+
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

Circle 200 on inquiry card.



New BITS Catalog Offered



The new BITS personal computer publications catalog is now available from BITS, 70 Main St, Peterborough NH 03458. The 13 page illustrated catalog is a comprehensive listing of over 100 personal computing books, all evaluated by the editors of BYTE. The books cover such topics as: fundamentals for the novice and knowledgeable; reference and resource publications; the art of computer programming; programming languages; the computer artist and musician; building your own computer; fun, games and foolishness; and many other areas of interest to the personal computer user. Write for your free catalog.■

Circle 598 on inquiry card.

Computer Interconnections From Hewlett-Packard

A new application note, *Computer Interconnections*, describes methods by which Hewlett-Packard HP 1000 computer systems and HP 9825 desktop computers can be interconnected to serve together in a wide range of instrument control measurement and analysis applications. It is available free of charge from Hewlett-Packard. The application note, AN 201-6, describes linking the two computers via different communications techniques: HP-IB (Hewlett-Packard's implementation of IEEE standard 488-1976), RS 232C and an HP 3070A terminal. Example programs and flowcharts depicting program-to-program communications for the different networks are included. Contact Inquiries Manager, Hewlett-Packard, 1507 Page Mill Rd, Palo Alto CA 94304.■

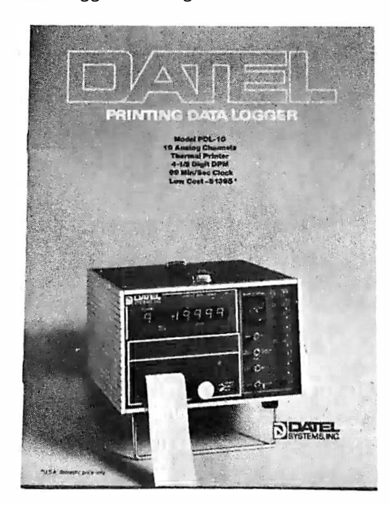
Circle 599 on inquiry card.

Electrical Engineering Fundamentals

A Programmed Review for Electrical Engineering is a review of electrical engineering fundamentals. Its primary emphasis is on solving the type of problems found on the Professional Engineering Examination. Each problem has been selected to illustrate a specific concept. Background material, in the form of tables, formulas, charts and graphs, provides all the necessary information to solve the problems. At least one solution is given for each problem. The book covers all the basic principles of electrical engineering. Special consideration is given to two significant areas: the field of digital logic and the study of engineering economics. An introductory section includes addresses of state licensing boards and guidelines for exam preparation. An extensive bibliography rounds out the volume. The book is written by James H Bentley and Karen M Hess PhD and is published by Van Nostrand Reinhold, 450 W 33rd St, New York NY 10001. The price is $14.50.■

Circle 600 on inquiry card.

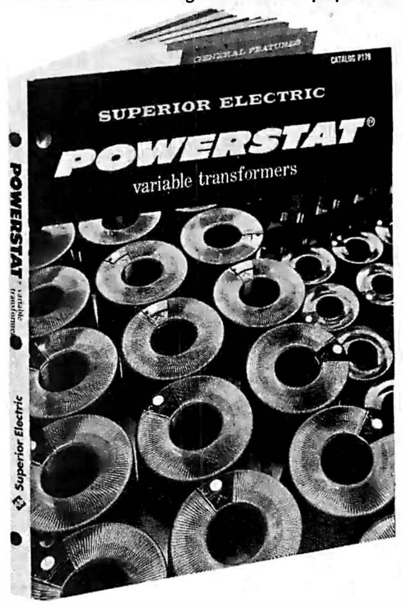
Hand Portable 10 Channel Printing Data Logger Catalog



A recently published 12 page brochure describing a high resolution printing data logger, Model PDL-10, is available from Datel Systems Inc, 1020 Turnpike St, Canton MA 02021. The PDL-10 offers a simple, low cost approach to measuring, scanning, and logging analog voltages. Ten input channels are provided, along with a 4½ digit panel meter, a 7 column thermal printer for instant hard copy printout, scan electronics, and a 99 minutes or seconds scan interval clock. Input connections are made through convenient rear panel terminals. This color brochure details electrical and physical parameters, operating instructions, block diagrams, application notes, and ordering information.■

Circle 601 on inquiry card.

Literature Available for Individuals Interested in Voltage Control Equipment



This 60 page powerstat variable transformer catalog P178 consolidates descriptive and technical data on the complete product line. It gives ratings, dimensions, performance curves and schematic connection diagrams in an easy to read format, and includes metric equivalents for universal use and easy reference. For a free copy write to the Superior Electric Company, 383 Middle St, Bristol CT 06010.■

Circle 602 on inquiry card.

New Software Buyer's Guide

A new publication, *Packaged Software Buyer's Guide,* is said to include 44 pages of important software information and can be helpful to any businessman who is contemplating purchasing such a system.

The guide is reported to give the prospective software buyer an in depth analysis of the following subjects: how to buy a software package for small business computers; how to buy a general ledger software package; the accounts receivable package; the accounts payable package; the payroll software package; and the inventory control package. Price is $15 from MIC, 140 Barclay Center, Cherry Hill NJ 08034.■

Circle 603 on inquiry card.

Computer Accessories Catalog

This catalog contains a wide variety of word and data processing supplies and equipment including: magetic tapes, cassettes, cards, cartridges, floppy disks, disk packs, paper tapes, rolls, continuous forms, thermal quiet paper, storage cabinets, containers, racks, reels, vertical format tapes, punches, splicers, automatic winders and more. Available from Computer Accessories Corp, 211 New York Av, Huntington NY 11743.■

Circle 604 on inquiry card.

S-100 32K STATIC MEMORY BOARD

features:

1. FULLY STATIC - usable with all DMA devices.
2. BUFFERED - with noise suppressed control inputs.
3. MODULAR - populated in 1k increments.
4. RELIABLE - single source +5V regulator
5. PROM COMPATIBLE - monitors available on request.

AVAILABLE EITHER IN **COMPLETE KITS** OR ALREADY **ASSEMBLED UNITS** WHICH HAVE BEEN FULLY TESTED AND BURNED IN.

BARE BOARD $38.00

	KIT	ASSEMBLED
8K	$270.00	$296.00
16K	$440.00	$465.00
24K	$580.00	$612.00
32K	$695.00	$740.00

PRICES QUOTED ARE FOR 300ns MEMORIES
KITS AND ASSEMBLED UNITS INCLUDE DOCUMENTATION

DEC® LSI-11 16K MEMORY BOARD

- Q-BUS—FULLY STATIC
- BUFFERED AND NOISE SUPPRESSED
- MODULAR
- PROM COMPATIBLE
- ADDRESSABLE TO 128K WORDS
- MAPPABLE IN 4K INCREMENTS

ASSEMBLED, TESTED & BURNED IN $1199.00 — COMPLETE KIT $1109.00

LARGEST & FASTEST STATIC MEMORY AVAILABLE

S-100 EXPANDABLE MOTHER BOARD

- 8-SLOT EXPANDABLE BACKPLANE—in line male and female connectors enable backplanes to be plugged together, or the female may be used in place of an extender board.

QUIET—ground plane decouples all signal lines.
RELIABLE—SAE 8100 phenolic body, gold contact connectors.

COMPLETE KIT $66.00 — ASSEMBLED $89.00

UNIVERSAL "U DESIGN" WIRE WRAP BOARDS

ALL BOARDS ARE G-10 GLASS EPOXY. HAVE Vcc AND GROUND PLANES. PLATED THROUGH HOLES. & GOLD PLATED EDGE CONNECTORS

No. 1 "BEST ON THE MARKET" **MICRO CPU CARD** WITH S-100 BUS. 3 ON BOARD REGULATORS. FITS ALL STANDARD I.C. SOCKET CONFIGURATIONS. 1700+ HOLES. SIZE 5"x10" — $23.95

No. 2 **UNIVERSAL BOARD** FITS 86 PIN SOCKET WITH 0.10" CONTACT SPACING. MADE BY LEADING COMPUTER MANUFACTURER AS "IN HOUSE" BOARD 1600+ HOLES SIZE 4-7/8"x7-5/8" — $7.95

S-100 EXTENDER BOARD

with connector

A MUST for trouble-shooting your Computer boards $17.95

BUILD YOUR OWN LOGIC PROBE

24 TO-92. SMALL SIGNAL DARLINGTONS AND 24 LEDS—ALL FUNCTIONAL only $4.95

MAXI SWITCH KEYBOARDS

UNENCODED-MOUNTED ON G-10 GLASS EPOXY BOARDS-A BLACK METAL FRAME KEEPS KEY SWITCHES SECURELY IN PLACE.

No. 1
- -53 key main keyboard
- -10 auxiliary & cursor control keys
- -11 key numeric pad
- -Bank of 5 auxiliary power and control, rocker arm switches-one of them lights up.

$39.95

WIRE WRAP SOCKET CONNECTOR FOR NO. 1 KEYBOARD $2.95

No. 2
- -53 key keyboard
- -1 auxiliary power/control DPDT rocker arm switch

$29.95

BEIGE METAL FRAME MOUNT FOR NO. 2 KEYBOARD $9.95

SOCKET CONNECTOR FOR NO. 2 KEYBOARD $2.95

OUR NEW ASCII KEYBOARD

HAS ON BOARD UV PROM, A MAIN KEYBOARD SECTION OF 58 KEYS, A HEX PAD OF 15 KEYS AND 16 MORE PERIPHERAL KEYS. 89 KEYS TOTAL & ASCII ENCODED for only $99.95

EDGE VIEW METER

CHARGE DISCHARGE SCALE READS -20.0,-40 MOVEMENT +60,-120mA 0.135 OHMS $2.49

POWER SUPPLY PARTS

DIODES

IN4001	50V at 1A	6c
IN4003	200V at 1A	8c
IN4007	1000V at 1A	12c
IN250	60V at 20A	95c
IN3909	50V at 30A	$1.25

BRIDGES

FAST RECOVERY AVALANCHE BRIDGE
IN4436/T 200V at 10A $4.25
FULL WAVE "MINI BRIDGE" WITH TAB TERMINALS
PR-10F 100V at 12A $3.75

5% ZENERS

IN4733A	5.1V	1w	39c
IN4739A	9.1V	1w	39c
IN4744A	15V	1w	39c

VOLTAGE REGULATORS

		PLASTIC	METAL
uA723 VARIABLE 2V to 3.7V		38c	69c
78LD5- 5V at 100mA	TO-92		3/98c
340T-6 6V at 1 AMP	TO-220		2/98c

PASS TRANSISTORS

MJE3055	10A	PLASTIC	89c
2N3055	10A	TO-3	95c
2N5301	30A	TO-3	$1.95

PROTECT YOURSELF. INSTALL AN ELECTRONIC CROWBAR CIRCUIT IN YOUR POWER SUPPLY.
CROWBAR SCR C220D 400V at 10A $1.75

BUILD YOUR OWN PAPER TAPE READER

1/10" CENTER STACKABLE **PHOTO TRANSISTORS** 10/$9.60

TTL COMPATIBLE REED RELAY

400 OHMS $1.49 — 7/$9.75

4K STATIC RAMS

2114	650ns	600mw	$6.25
TMS-4045-4	450ns	300mw	$10.95
HM-472114	300ns	200mw	$11.95

MINIATURE 16 BUTTON PADS

4x4 MATRIX ENCODED $1.95

I.C. SOCKETS

LOW PROFILE-SOLDERTAIL

	GOLD INLAID	TIN
8 PIN	10/$1.59	10/$1.35
14 PIN	10/$1.89	10/$1.49
16 PIN	10/$1.99	10/$1.59
22 PIN	5/$1.69	5/$1.49
24 PIN	5/$1.89	5/$1.59
28 PIN	5/$1.99	5/$1.69
40 PIN	4/$1.99	4/$1.69

for that professional touch **CARBIDE DRILL BITS for P.C. BOARD WORK**

ASSORTMENT OF SIZES FROM NO. 55 TO NO. 70
5 MIX/$7.49 — 10 MIX/$12.49 — 100 MIX/$99.00

GOLD WIRE WRAP SOCKET STRIPS

MAKE UNIVERSAL END AND SIDE STACKABLE WIRE WRAP BOARDS

7 PIN STRIP — TOP VIEW — SIDE VIEW

12 PIN 3 LEVEL 48c
14 PIN 2 LEVEL 48c
3 LEVEL 56c

OPTO DEVICES

PHOTO TRANSISTORS SIMILAR TO FPT 100 4/98c

ULTRA HIGH SPEED **PHOTO DETECTOR** 0.5ns RISE TIME $3.75

EXTREMELY SENSITIVE LIGHT-ACTIVATED **SCR** triggerable by flashlight at several hundred yards $2.95

PHOTO DARLINGTONS MOTOROLA 4/98c

INFRA RED DETECTOR

ULTRA LOW LEVEL
PIV 7V
I on 1ma $4.95

SOLAR CELLS

2x2cm 130ma
$1.59 ea. 10/$9.90

HEWLETT-PACKARD JUMBO-RED HIGH EFFICIENCY **LED**
ON BOARD STATUS INDICATOR 6/$1.00

HIGH INTENSITY RED **LED LAMP**
EXTREME WIDE ANGLE VIEWING
3/98c 10/$2.45

GOLD EDGE CARD CONNECTORS

No. 1 SAC185/2-2 SINGLE ROW, 18 PIN CONNECTOR WITH 0.156" CONTACT SPACING. 99c

No. 2 SAC22S/2-2 SINGLE ROW, 22 PIN CONNECTOR WITH 0.156" CONTACT SPACING 99c

No. 3 2VH31/ICB6 31 SOLDER LUG CONNECTOR WITH 0.125" CONTACT SPACING 99c

WIRE WRAP POST

2 LEVEL
10 9.8c
100 $7.40
1000/$64.00
3 LEVEL
10 $1.25
100 $8.60
1000/$72.00

HI-REL GOLD WIRE WRAP SOCKET PIN

10/$1.20
100/$9.00
1000/$79.00
LIST PRICE 29c

OP AMPS

SINGLE
709 10c
741 12c
DUAL
MC1458 39c
QUAD
LM3900 49c

DIODES

IN91	15c
IN270	12c
IN914	15c
IN3600	15c
IN4148	10c

TRANSISTORS

2N2222	12c
2N3904	12c
2N3906	12c
2N3053	49c

D/A CONVERTER

SIGNETICS NE5008 $9.95

SUB MINIATURE CRYSTAL FILTER

455 KHZ WITH DATA $2.95

LEDS

YELLOW, GREEN, OR AMBER (SPECIFY COLOR) 3/88c

HIGH VOLTAGE DIODES

EPOXY	1500V at 1 AMP	10/$1.99
EG250	2500V at 350mA	95c
HV60EL	6KV at 25mA	$1.95
SUBMINIATURE	20KV at 100mA	$2.95

NO BACK ORDERS

YOUR PARTS OR *IMMEDIATE* REFUND

FREE DELIVERY BY UPS ON U.S. ORDERS ONLY!

OR BY SURFACE MAIL. IF SPECIFIED — CALIF. RES. ADD 6% SALES TAX

MONEY BACK GUARANTEE (MOS AND LED DEVICES EXCLUDED) $20 MINIMUM

FOR UNDER 8 HOUR PROCESSING SEND MONEY ORDER, CERTIFIED OR CASHIERS CHECK.
SORRY! WE CANNOT ACCEPT PURCHASE ORDERS, COD'S, PHONE ORDERS OR CREDIT CARDS.

F. Reichert Sales
1110 E. GARVEY AVE.
W. COVINA, CA. 91790

3-1/2 DIGIT L.C.D.'s

LIQUID CRYSTAL DISPLAY

No. 1 0.4" CHARACTER WITH CONNECTOR $6.95

No. 2 THIS MINIATURE L.C.D. IS IDEAL FOR POCKET SIZED INSTRUMENTS $3.95

FOREIGN ORDERS

CANADA, PUERTO RICO, U.S. POSSESSIONS ADD U.S. $3.50. ALL OTHER ADD U.S. $7.00. IMMEDIATE SHIPPING ON CHASE MANHATTAN, FIRST CITIZENS, CASHIERS CHECKS & CANADIAN POSTAL MONEY ORDERS

DROP INTO ONE OF OUR LOCATIONS

LOS ANGELES (213) 967-4611 **LMN ELECTRONICS** 1042 E. GARVEY AV. W. COVINA, CA (VINCENT & SAN BERDO. FWY.) TUE to SAT 10-8—CLOSED SUN & MON

PORTLAND (503) 646-4044 **WIZARD OF PARTS** 8225 SW CIRRUS DR. BEAVERTON, ORE (KOLL BUS. CNTR/WASHINGTON SQUARE)

DENVER (303) 573-5214 **ELECTRONIC LOLLIPOP** 5643 N. BROADWAY, DENVER, CO. (I-25 & 58th AVE.)

ALL ITEMS SUBJECT TO PRIOR SALE — PRICES SUBJECT TO CHANGE

Circle 207 on inquiry card.

Circle 247 on inquiry card.

cybercom BOARDS

MB-1 MK-8 Computer RAM (not S-100), 4KX8, uses 2102 type RAMs, PCBD only $22.00

MB-3 1702A EROM Board, 4KX8, S-100 switchable address and wait cycles, kit less PROMS $58.00

MB-4 Basic 4KX8 ram, uses 2102 type rams S-100 buss. PC board $24.95

MB-6A Basic 8KX8 ram uses 2102 type rams, S-100 buss. PCBD $24.95

MB-7 16KX8, Static RAM uses µP410 Protection, fully buffered. KIT $375.00

MB-8A 2708 EROM Board, S-100, 8KX8 or 16KX8 kit without PROMS $75.00

MB-9 4KX8 RAM/PROM Board uses 2112 RAMS or 82S129 PROM kit without RAMs or PROMs $72.00

10-2 S-100 8 bit parallel I/O port, 2/3 of boards is for kludging. Kit .... $46.00 PCBD $24.95

10-4 Two serial I/O ports with full handshaking 20/60 ma current loop: Two parallel I/O ports. Kit .... $130. PCBD $24.95

VB-1B 64 x 16 video board, upper lower case Greek, composite and parallel video with software, S-100. Kit .... $125.00 PCBD $24.95

Altair Compatible Mother Board, 11 x 11½ x ⅛". Board only .... $40.00. With 15 connectors $90.00

Extended Board full size. Board only .... $ 9.00

With connector $13.00

SP-1 Synthesizer Board S-100

New Low Price .... Kit $135.95

		PRIME DEVICES	
82S23	$1.50		
82S123	1.50		
82S126	1.95	8080A	$11.50
82S129	1.95	8212	3.75
82S130	3.00	8214	6.50
82S131	3.00	8216	3.95
MMI6330	1.50	8224	4.00
4N26	.75	8228	6.95
4N27	.75	8251	9.95
4N2E	.75	8255	9.95
LM323	2.95	21L14	8.50

WMC inc. WAMECO INC.

MEM-1 8KX8 fully buffered, S-100, uses 2102 type rams. PCBD $24.95

Mother Board 12 slot, terminated, S-100, board only $30.95

CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD $24.95

RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD $23.95

EPM-1 1702A 4K Eprom card PCBD $24.95

EPM-2 2708/2716 16K/32K EPROM CARD PCBD $24.95

SHORT MOTHER BOARD Short Version of QM-1A 8 Slots PCBD $25.95

2102AL-2 Prime 250 NSEC	$1.70
2102AL-4 Prime 450 NSEC	$1.30
2708 Prime (National)	$10.00
1702A-6 AMD Prime	$3.50
1702A Intel Not Prime (2US)	$2.00

2501B	$1.50	1488N	$1.50
2502B	1.50	1489N	1.25
2504	1.50	MC4044	2.25
2507V	1.50	8038	3.90
2510A	1.50	5320	5.95
2517V	1.50	5554	1.90
2518B	1.50	5555	2.50
2519B	1.50	5556	2.50
2521	1.50	5055	1.25
2522	1.50	5312	4.00
2525	1.50	MH0025	1.50
2527	1.50	MH0026	1.75
2532V	1.50	MH0028	1.90
2529	2.75	5262	.50
2533V	1.95	2101	3.50

MIKOS PARTS ASSORTMENTS

All piece parts for assembly of Wameco and SSM PCBD's. All Factory Marketed Parts. Order PCBDs right.

Mikos #1 Parts for MEM-1 PCBD with prime 2102AL-4 450 nsec rams. Less PCBD $105.00

Mikos #2 Parts for CPU-1 PCBD with prime 8080A 8212's and 8214. Less PCBD $62.00

Mikos #3 Parts for MEM-1 PCBD with prime 2102AL-2 250 nsec rams. Less PCBD $128.00

Mikos #4 Parts for QM-1A with super low loss gold plated connectors. Less PCBD. $52.00

Mikos #5 Parts for RTC-1. Less PCBD $40.00

Mikos #6 Parts for VB-1B less molex connectors and PCBD. $65.00

82S06	$1.00	8T26	$2.00
82S07	1.00	8T28	2.00
82S50	1.00	8T34	2.50
82S62	1.00	8T37	2.50
75324	1.50	8T38	2.50
75325	1.50	8T74	1.50
8T01	2.50	8T80	2.50
8T09	1.25	8T90	2.50
8T10	2.50	8T95	2.30
8T13	2.50	8T96	2.45
8T14	2.50	8T97	1.50
8T20	2.50	8T98	2.00
8T23	3.00	8T110	2.00
8T24	2.50	567	1.50

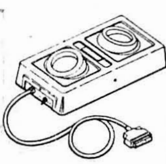
MIKOS

419 Portofino Drive
San Carlos, California 94070

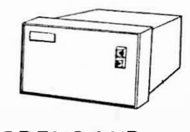
Please send for IC, Xistor and Computer parts list.

Check or money order only. If you are not a regular customer and your order is large please send either a cashier's check or a postal money order, otherwise there will be a delay of two weeks for the check to clear. All items post paid in the U.S. Calif. residents add 6% tax. Money back 30 day guarantee. We cannot accept returned IC's that have been soldered to. Prices subject to change without notice. **$10 minimum order. $1.00 service charge on orders less than $10.**

COMMERCIAL GRADE EQUIPMENT - HOBBYIST PRICES!!

TAPE DRIVES



MODEMS AND PHONE COUPLERS



SELECTRIC TERMINALS

NO RISK ! 7 DAY APPROVAL ON ALL MAIL-ORDERS. FULL REFUND ON RETURNS.

- **AMPEX MODEL TMX TAPE DRIVES** with built-in NRZ1 formatter. 800 BPI, 9 track, 12 IPS, 8" reel includes 8 bit CPU controller diagram and 8080 interface instructions. Ideal for microcomputerist who wants back-up mass storage and access to IBM-type systems via standardized ½" mag tape . . . $750
- **AMCOMP SERIES 2700 TAPE DRIVES:** current model, vacuum column control; like new:
  - (2) MODEL 2749 - 45 ips, 800 BPI, 7-Track, 10" reel $1500
  - (3) MODEL 2769 - 125 ips, 800/1600 BPI, 9-Track, 10" reel . . $3000
- **TAPE DRIVE FORMATTERS**, "Pertec Standard Interface":
  - (3) AMCOMP SERIES 2900 NRZI/Phase Encoded, 25-125 ips . . $1500
  - (1) PICO MODEL 1011, NRZ1, 800 BPI FORMATTER / CONTROLLER for PDP–11 . . . . $2000
- **MODEMS**, Full-Duplex, Auto Answer circuitry, by VADIC CORP.
  - BELL 103 Type (300 Baud) Circuit Card only $75
  - BELL 103 Circuit Card, Power Supply, Case, Connectors $125
  - BELL 202 Type (1200 Baud) with Reverse Channel Transmission from $125
- **DB-25 MALE CONNECTOR** + 2 wire cable to Phone Jack $4
- **PAPER TAPE READER** (ADDMASTER 601-1): 150 cps, LED sensors read 5-8 level tapes, bi-directional stepper motor, includes TTL serial interface plus 8080 parallel interface instructions. Requires +5V & 24V $90
- **DATATEST PROGRAMMABLE AUTOMATIC CIRCUIT CARD ANALYZER**
  - MODEL 4000A $2000
  - MODEL 4700 . . . . $6000
- **DIABLO SYSTEMS** Spare Circuit Cards for HyType Printer, Series 20 + 40 Disk Drives; complete but defective or below current revision level $20
- **ASCII ENCODED KEYBOARD** from HyType Terminal, never used $60
- **TELEPHONE ACOUSTIC COUPLER** $30

- **SELECTRIC I/O TERMINALS** (by GTE/INFORMATION SYSTEMS). Includes 8080 interface plus software ASCII translation and I/O driver routines 15" carriage, interchangeable type spheres & carbon/fabric ribbons. Built-in modem optional.
  - MODEL 5541 (IBM Correspondence Code, 2741-type terminal) $895
  - MODEL 5550 (Corres. Code w/350 char. line buffer memory + built-in cassette drive for data storage/off-line printing/word processing . . $1495
  - MODEL 5560 (ASCII Code, with cassette tape drive) $1495
- **IBM SELECTRIC TYPEWRITER** with magnets, switches & magnet driver PCB (from GTE/IS Terminal) plus instructions for 8080 printer/driver interface. Typewriter mechanism complete, cleaned & adjusted $325
  Aluminum Case & Power Supply (+24V, ±12V, +5V @ 5V) $75
- **CONVERT IBM OFFICE SELECTRIC** to I/O Typewriter: solenoids, switches, wire harness, magnet driver PCB plus instructions + 8080 Interface Diag. $150
- **IBM PIN-FEED PLATENS** for 15" SELECTRICS (13 1/8 pin-to-pin) new $50
- **IBM SELECTRIC APL TYPE SPHERES** (Specify EBCDic or Correspondence Code), new $15
- **FORMS TRACTORS**, Moore Variable-width "Form-A-Liner" . . . . . . new $50 for 15" Carriage IBM SELECTRICS . . . . used $30
- **DIGITAL CASSETTE DRIVE** (from GTE/IS Terminal) 2400 baud, FWD/REWIND/STOP circuitry, plus tape head, but no read/write electronics . . $25
- **INTERDATA 8-BIT MINICOMPUTER** (Model One), includes full front panel, 4K core memory (16K addressable), plug-in teletype port; optional serial I/O + Tape Drive Controller PCB's.software $300
- **RIBBON CABLE** 50 Strand X 4' long terminated with 3M edge connector (.10" spacing) + paddle card $3
- **AC LINE FILTER** 10AMP RFI (110/230V) with Line Relay + Fuses new $15

Call or write for details, quantity discounts, order forms. All orders shipped from stock – no back orders, no substitutions. All equipment is shipped insured FOB Palo Alto within 7 days after check clears or COD order is received. M/C & VISA cards accepted.

PACIFIC OFFICE SYSTEMS, INC.
2600 EL CAMINO REAL, SUITE 502
PALO ALTO, CALIF. 94306
Tel: (415) 321 - 3866

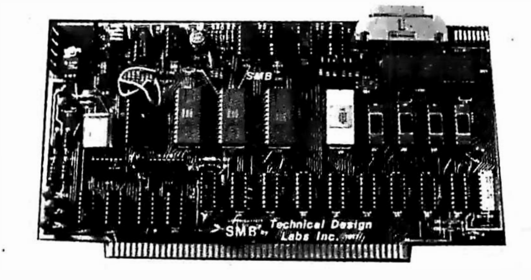
90 day warranty against defects in material or workmanship on all used equipment. Full documentation included PLUS interface instructions where indicated. Availability subject to prior sale. Prices may change without notice.

Circle 296 on inquiry card.

Close-out Purchase by MiniMicroMart

Save up to 50%

on the famous TDL SMB System Monitor Board



TWO SERIAL PORTS, PARALLEL PORT, MONITOR ROM, 2K OF RAM, AND CASSETTE INTERFACE ON ONE BOARD. FEATURE ARTICLE IN APRIL BYTE.

— AVAILABLE BARE BOARD, PARTIAL KIT, COMPLETE KIT, OR ASSEMBLED AND TESTED —

FEATURES

- Does power-on jump to monitor
- Two fully programmable serial ports (110 to 9600 baud RS232 or 20-mil loop)
- Programmable 8-bit I/O port
- Provision for 1200-baud audio cassette interface
- Provision for 1K or 2K on-board static RAM
- Provision for 2K ROM (TDL Zapple Monitor or, with minor changes, one 2708 or 2716 EPROM)

SMB Bare Board w/const. manual .	05-1002-0	$ 49.95
SMB Board, all IC sockets, addressing and buffering components, power-on jump circuits and support circuitry for ROM/RAMs	05-2002-1	99.50
SMB Board, same as above but incl. all components for one parallel/one serial interface	05-2002-2	119.50
SMB Complete Kit, incl. parallel port, two serial ports, audio cassette interface . .	05-3002-0	147.50
SMB Assembled and Tested	05-4002-0	197.50
Zapple Monitor ROM for above	05-9002-0	29.95
1K RAM (two EMM 4148's) for above	05-6002-0	29.95

Add $2.00 for shipping and insurance.

RAMS/EPROMS

Prime 2708 EPROMs
full spec, 450ns
$9.95 each

EMM4200 4K Static RAMs
$10.95 each

T.I. 4K Static RAMs

4K x 1 TMS 4044's
(as used in Heath boards)
$8.98 each

1K x 4 TMS 4045's
$9.89 each

4K x 1 TMS 4027-25's (16-pin)
$3.95 each

IBM 735 I/O Selectrics (used)

from **$395.00**

CLOSE-OUT SPECIALS

S-100 16K Static RAM Boards
for EMM 4200's (bare boards)
$24.95

S-100 1702 EPROM board
(holds 8 PROMs) complete kit
$49.95

S-100 4K Static RAM Board Kit (less 2102's)
$19.95

CONTACT US FOR ADD-ON MEMORY FOR TRS-80

S-100 Prototype Boards
General-Purpose
$18.95

Wire-Wrap Version
$19.95

ASCII Keyboards

Used surplus
Excellent condition
Control functions
Upper/lower case
Ready to use
$49.95

Teletypes (used)

— IMMEDIATE DELIVERY —

KSR-33's . . . . . . from **$495.00**
ASR-33's . . . . . . from **$695.00**

LOTS OF OTHERS

Write for close-out and surplus catalog for fantastic prices on TV Typewriter III boards and kits, cursor boards, screen-read boards for above (can also be used with SWTP CT-1024); also, 25 x 40 video boards, UART boards, and Baudot-to-ASCII conversion boards.

MiniMicroMart, Inc.

1618 James Street, Syracuse NY 13203
Phone (315) 422-4467

Circle 251 on inquiry card.

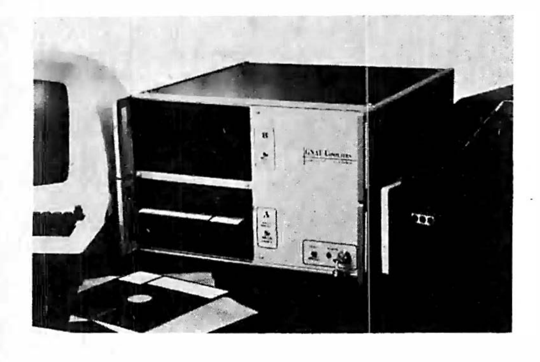
INFO 2000 Disk System Upgrades Heathkit H8 to Z-80



A complete disk system for the Heathkit H8 has been announced by the INFO 2000 Corporation, 20630 S Leapwood Av, Carson CA 90746. The INFO 2000 Disk System is designed to upgrade the 8080 computer to a Z-80 system by replacing the Heathkit 8080 processor board with the INFO 2000 Z-80 disk adapter board. The complete disk system for the H8 computer includes PerSci dual diskette drives, power supply, case, intelligent controller, adapter, cables and disk monitor in erasable read only memory. The adapter board contains the Z-80 microprocessor and all support chips, 7 K of erasable read only memory, 1 K of scratchpad programmable memory for the disk monitor, and all necessary logic for interfacing the disk system to the Heathkit H8. With the addition of the system and installation of its adapter board, the H8 computer can operate in either of two switch selectable modes. One mode enables continued use of the H8 erasable read only memory monitor with the existing Benton Harbor software. The second mode supports the disk monitor, and other software adapted to the system for use with all their disk systems. Cost for the complete system is $2750 with a 90 day warranty. A 5% discount is offered when payment in full accompanies order.■

Circle 634 on inquiry card.

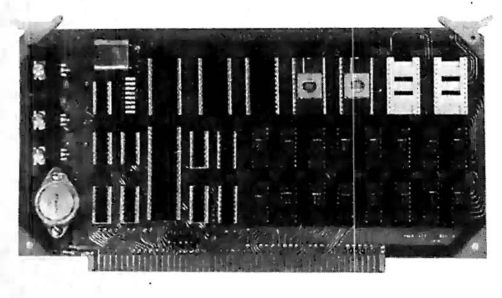
Microcomputer System Features Dual Disk Drives



The GNAT-PAC System 9 which integrates the GNAT microcomputer system with dual standard floppy disk drives is now available. With disk storage of up to 1 million bytes, the System 9 is intended for use in small business applications, communications, or process control. The standard computer hardware includes the 8080A processor, 32 K bytes of programmable memory, 16 K bytes of read only memory with 2 K bytes of programmable read only memory, 4 RS-232 serial IO ports, and floppy disk controller. Dual disk drives provide 500 K bytes of disk storage per drive. The System 9 is packaged in a 10½ inch high cabinet (26.67 cm) and includes card rack, fan, 11 slot mother board, RFI line filter, wiring and power supply. Software includes a monitor, loader, disk operating system with assembler, editor and dynamic debugger. FORTRAN, BASIC and other high level languages are available. Price is $5500 from GNAT Computers Inc, 7895 Convoy Ct, Unit 6, San Diego CA 92111.■

Circle 635 on inquiry card.

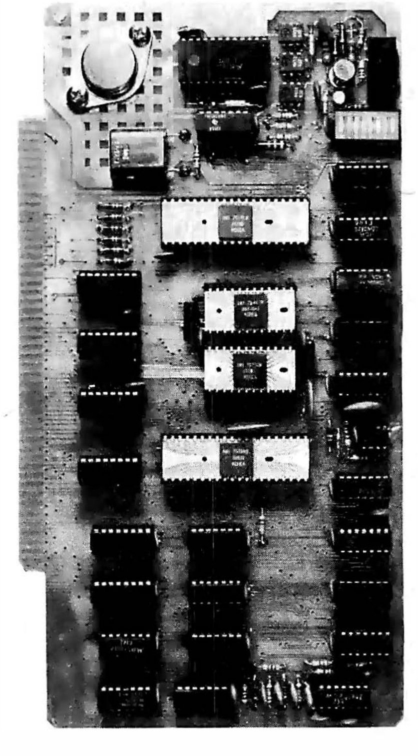
Single Board Microcomputer Holds 8 K PROM plus 8 K Volatile Memory



The Little Brain I is a microcomputer using the 6802 processor mounted on an S-100 board which includes as much as 8 K words of ultraviolet erasable read only memory and 8 K words of fully static programmable memory plus an RS-232C channel on a single board. The Little Brain I has on-board voltage regulators, fully buffered address, data and control buses along with a 128 word scratchpad memory. Custom programming services are available. The fully socketed version with a 2 K monitor and debug program and 1 K words of programmable memory sells for $395 and is backed with a one year warranty. Contact BPI Electronics, 4470 SW 74th Av, Miami FL 33155.■

Circle 636 on inquiry card.

Microprocessor Card for S-100 Bus



The 6800-CPU microprocessor card for the S-100 bus brings all the advantages of the 6800's architecture to the S-100 user. The software support for the 6800 is now available to the S-100 bus user. For the small business user or personal computer user, this microprocessor card provides full turnkey operation and maximum system compatibility as well as an RS-232 20 mA interface (bps rate selectable with a DIP switch), paper tape reader control, Motorola MIKBUG read only memory operating system, power on reset, on board dynamic memory refresh, slow memory interfacing and three state data, address, and control lines. Prices are $179 in kit form and $269 assembled, burned in and tested. Contact Datatronics, 208 E Olive, Lamar CO 81052.■

Circle 637 on inquiry card.

Ohio Scientific Catalog

Now available from Ohio Scientific is a 19 page illustrated catalog detailing a full line of computers, software and hardware for personal and business use. Prices range from $298 for their C2-0 Model 500 which is a complete computer on a board featuring standard 8 K BASIC in read only memory, 6502 microprocessor, 4 K of programmable memory and a serial port up to $3590 for the C3-S1 Challenger 111 System with dual drive floppy, 32 K programmable memory, serial port, cabinets and power supplies. For this free catalog write Ohio Scientific, 1333 S Chillicothe Rd, Aurora OH 44202.■

Circle 638 on inquiry card.

FREE PROBES FREE PROBES FREE PROBES





1¢ SALE

LM3A 3 dig 1% DC .... $125.
LM3.5A 3½ dig .5% DC .... $147.
LM40A 4 dig .1% DC.......... $190.
LM4A 4 dig .03% DC $227

- Rechargeable batteries and charger included
- Measures DC Volts, AC Volts, Ohms and Current
- Automatic polarity, decimal and overload indication
- Rechargeable batteries and charger
- Measures DC Volts, AC Volts, Ohms and Current
- Automatic polarity, decimal and overload indication
- No zero adjustment and no full-scale ohms adjust
- Battery-operated — NiCad batteries; also AC line operation.
- Large LED display for easy reading without interpolation
- Size: 1.9"H x 2.7"W x 4"D
- Parts & labor guaranteed 1 year
- Tilt stand option .... $ 3.50
- Leather case $16.00

Purchase any of the LM series Meters and buy the LEATHER CASE for 1¢

NLS

$289

MS-15 MINISCOPE *With Rechargeable Batteries & Charger Unit*

- 15 megahertz bandwidth.
- External and internal trigger.
- Time base — .1 microsec. to 0.5 Sec/div - 21 settings . ±3%.
- Battery or line operation.
- Automatic & line sync modes.
- Power consumption < 15 watts.
- Vertical Gain — .01 to 50 V/div - 12 settings ±3%.
- Viewing area 1.1" x 1.35".
- Case size 2.7"H x 6.4"W x 7.5"D, 3 pounds.
- Parts & Labor guaranteed 1 year
- 10 to 1, 10 meg probe $24.50
- Leather carrying case $30.00

PROBE 1¢
PROBE 1¢ with the purchase of SCOPE and the MENTION of this MAGAZINE

NLS

- MS-215 Dual Trace Version of MS-15 $395.00

3 LEVEL GOLD WIRE WRAP SOCKETS

	1-24	25-49	50-99	100-249	250-999	1K-5K
8 pin*	.41	.38	.35	.31	.27	.23
14 pin*	.39	.38	.36	.32	.29	.27
16 pin*	.45	.42	.39	.35	.33	.30
18 pin	.63	.58	.54	.47	.42	.36
20 pin	.80	.75	.70	.63	.58	.53
22 pin	.90	.85	.80	.70	.61	.57
24 pin	.90	.84	.78	.68	.63	.58
28 pin	1.10	1.00	.90	.84	.76	.71
40 pin	1.50	1.40	1.30	1.20	1.04	.89

3 LEVEL GOLD WIRE WRAP SOCKETS

Sockets purchased in multiples of 50 per type may be combined for best price.
All sockets are GOLD 3 level closed entry. End and side stacable. 2 level, Solder Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION

SALE S-100 BUS EDGE CONNECTORS SALE

S100-WWG 50/100 Cont. .125 ctrs. 3 LEVEL WIRE WRAP .025" sq. posts on .250 spaced rows. GOLD plated.

1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-WWN 50/100 Cont. .125 ctrs. 3 LEVEL WIRE WRAP .025" sq. posts on .250 spaced rows. NASGLO tin-nickel plated.

1-4	5-9	10-24
$3.50	$3.25	$3.00

S100-STG 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR and IMASI motherboards GOLD plated.

1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-STN 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR and IMASI motherboards. NASGLO tin-nickel plated.

1-4	5-9	10-24
$3.50	$3.25	$3.00

RG81G 50/100 Cont. .125 ctrs. DIP SOLDERTAIL on .140 spaced rows for ALTAIR motherboards. GOLD plated. $5.00

R681-3 50/100 Cont. .125 ctrs. PIERCED SOLDER EYELET tails. GOLD $7.35

Other Popular Edge Connectors

R644-G 22/44 Cont. .156 ctrs. PIERCED SOLDER EYELES tails. GOLD plated.

1-4	5-9	10-24
$3.00	$2.75	$2.50

R644-3 22/44 Cont. .156 ctrs WIRE WRAP tails. GOLD $4.71

ATTN: OEM'S and Dealers, many other connectors available call or quotation.

8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS — Vector

- Kit includes 12 tantalum capacitors for +5, +12, −12 buses and insulated mounting spacers.
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads
- Solder mask with solder windows on etched circuits to avoid accidental short circuits
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing, Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active pull-up, or floating terminations
- Large buses +5V and GND (10 AMPS) ±12V or 16V (7 AMPS) Current ratings are per MIL-STD-275 with 10°C rise
- Fits in Vector-pak enclosures
- Fits in IMSAI 8080 microcomputer as expander board

Price: $29.50

Vector Plugboards

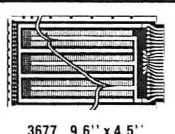


8800V
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware 5.3" x 10" x 1/16

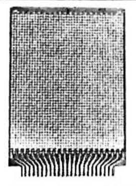
1-4	5-9	10-24
$19.95	$17.95	$15.96

8801-1
Same as 8800V except plain: less power buses & heat sink

1-4	5-9	10-24
$14.95	$13.46	$11.96

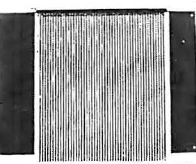


3682 9.6" x 4.5" $10.97
3682-2 6.5" x 4.5" $9.81
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156

3662 6.5" x 4.5" **$7.65**
3662-2 9.6" x 4.5" **$11.45**
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156



3690-12 CARD EXTENDER
Card Extender has 100 contacts-50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems............ $25.00
3690 6.5" 22/44 pin .158 ctrs. Extenders...... $12.00

1/16 Vector BOARD
.042 dia holes on 0.1 spacing for IC's

Phenolic PART NO.	SIZE	PRICE 1-9	10-19
64P44XXXP	4.5x6.5"	$1.49	1.34
169P44XXXP	4.5x17"	$3.51	3.16
Epoxy Glass			
64P44	4.5x6.5"	$1.70	1.53
84P44	4.5x8.5"	$2.10	1.89
169P44	4.5x17"	$4.30	3.87
169P84	8.5x17"	$7.65	6.89

SLIT-N-WRAP



Wraps insulated wire on .025" square posts
FOUR TIMES FASTER than regular manual wrap post tools

P180 with two 100' spools of 28 ga. wire **$24.50**

P160-4T includes charger, wire **$75.00**

Vector

NO PRE-STRIPPING*
NO PRE-CUTTING*
SPOOL-FED WIRE*
*The spooled wire passes through the tool past a slitting edge next to the wrap post. A narrow longitudinal cut is made in the insulation where it presses the square post corner. The bared copper is indented by the sharp edge (7 turns = 28 contacts). Insulation is slit where wrapped but not between terminal posts when led straight out of the tool.

"Daisy-chain" runs. Reliable and easy to use. Manual or power operation

SLIT-N-WRAP WIRE $2.75 Package
NO. 28 GAGE INSULATED WIRE, 100' SPOOLS
W28-2-A-Pkg 3 Green W28-2-C-Pkg 3 Clear
W28-2-B-Pkg 3 Red W28-2-D-Pkg 3 Blue

2708
8K 450 ns
EPROM
FACTORY PRIME
$10.00 EA.
25 + *Call For Price*

WOW 14 & 16 PIN GOLD 3 LEVEL WIRE WRAP SOCKETS



14 - G3 100 for $30.00
16-G3 100 for $30.00
50 of each for $32.00
Sockets are End & Side stackable, closed entry

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

- For Auto, Home, Office
- Small in size (2x2½x½)
- Pushbutton for seconds release for date.
- Clocks mount anywhere with either 3M double-sided tape or VELCRO. Included.
- 2 MODELS AVAILABLE: LCD-101, portable model runs on self-contained batteries for better than a year. LCD-102, runs on 12 Volt system and is back-lighted.
- LCD-101 or LCD-102 your choice **$34.95**
- Clear desk stand for **$2.00**





Perfectly balanced, fluorescent lighting with precision magnifier lens. For prof'l, techn'l & hobbist. Has die cast protective shade, inst start 3 diopter lens. 42" reach.

$44.95

SPECIAL

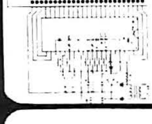


FM-7 With Rechargeable Batteries & Charger Unit **$195**

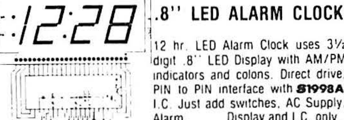
SC-5 With Rechargeable Batteries & Charger Unit **$89**

Features Include: • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands). • The FM-7 utilizes an LED readout, providing 7-digit resolution. • The FM-7 can be calibrated to an accuracy of 0.00001%. • The SC-5 is accurate to one part per million. • Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included. • Dimensions of each are 1.9" H x 2.7" W x 3.9" D. • The units may be obtained separately or as a "Frequency Duo." • Parts & Labor guaranteed 1 year.
Tilt stand option .... $ 3.50
Leather case $16.00

NLS



MICRO-KLIP
for .042 dia. holes (all boards on this page)
T42-1 pkg. 100 $ 1.50
T42-1 pkg. 1000 ...... $11.00
P-149 hand installing tool ...... $ 2.03

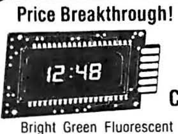


.8" LED ALARM CLOCK

12 hr. LED Alarm Clock uses 3½ digit .8" LED Display with AM/PM indicators and colons. Direct drive, PIN to PIN interface with **S1998A** I.C. Just add switches, AC Supply, Alarm. Display and I.C. only

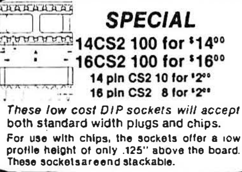
$7.95 or 2/$15.00

Price Breakthrough! $17.50



MA1003 CAR CLOCK

Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC.



SPECIAL

14CS2 100 for $14.00
16CS2 100 for $16.00
14 pin CS2 10 for $2.00
16 pin CS2 8 for $2.00

These low cost DIP sockets will accept both standard width plugs and chips.
For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are end stackable.



Vector

WRAP POST
for .042 dia. holes (all boards on this page)
T-44 pkg. 100 .. $ 2.28
T-44 pkg. 1000 .... $14.00
A-13 hand installing tool ...... $ 2.80

PRIORITY ONE ELECTRONICS ©

10031 A Woodley Ave. Sepulveda CA. 91343



Terms: VISA, MC, BAC, check, Money Order, C.O.D., U.S. Funds Only. CA residents add 6% sales tax. Minimum order $10.00. Orders less than $75.00 include 10% shipping and handling, excess refunded. Just in case please include your phone no. **"Sorry, no over the counter sales"** Good thru Aug 15, 1978

Send for our latest brochure.

phone orders welcome (213) 893-8202

OEM and Institutional inquiries invited.

24 PIN DIP PLUGS WITH COVERS



3 / $1.00
40 / $10.00

NLS MS-215 DUAL TRACE MINISCOPE $395.00

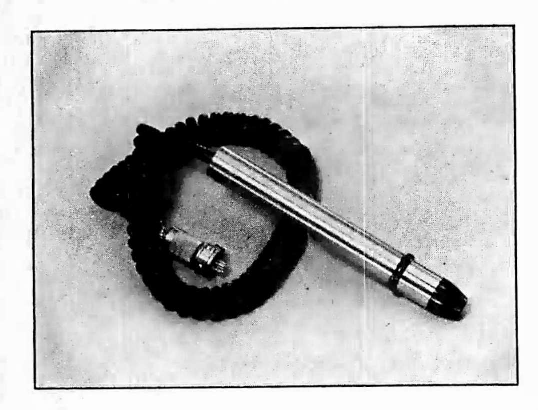
NLS MS-215 DUAL TRACE MINISCOPE $395.00

FREE PROBES FREE PROBES FREE PROBES

Circle 304 on inquiry card.

What's New?

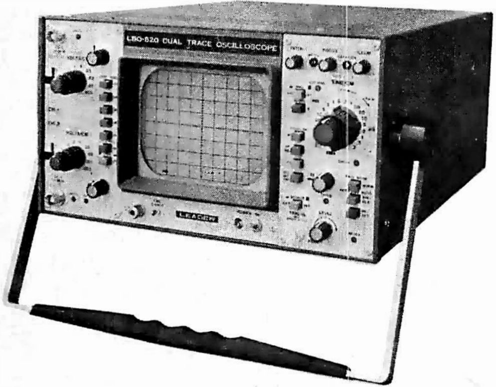
Light Pen Literature Available



A new model LP-316 super high sensitivity light pen for long or different focal distances has been introduced by Information Control Corp, 9610 Bellanca Av, Los Angeles CA 90045. The pen features a finder beam to locate the target, and patented touch sense activation to allow the pen to be held back away from the screen for better visibility. Luminous sensitivity can be adjusted down to 0.5 footlamberts. The LP-316 carries a full year warranty. For more information and a complete catalog of ICC light pens, contact the company.■

Circle 645 on inquiry card.

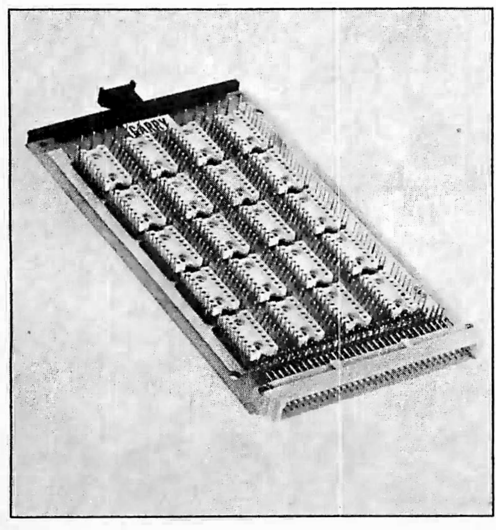
Wide Applications for New 30 MHz Dual Trace Scope



The LBO-520 oscilloscope is a 30 MHz dual trace instrument with a fixed delay line. According to the manufacturer, it has been designed for applications requiring high accuracy signal viewing, single shot trigger, built-in delay and high sensitivity. It is further reported that the unit has 5 mV sensitivity to facilitate accurate signal viewing from video cameras and other low level sources. The instrument's 1 shot trigger, on both channels, assures instant capture of transient phenomena without guesswork or double takes. A 20 ns per cm sweep capability combined with a rise time of 11.7 ns lets the observer view the fastest signals in typical small computer systems with ease. The 120 ns built-in delay line permits easy viewing of the leading edge of a pulse or pulse train for quick determination of signal characteristics. Contact Leader Instruments Corp, 151 Dupont St, Plainview NY 11803.■

Circle 646 on inquiry card.

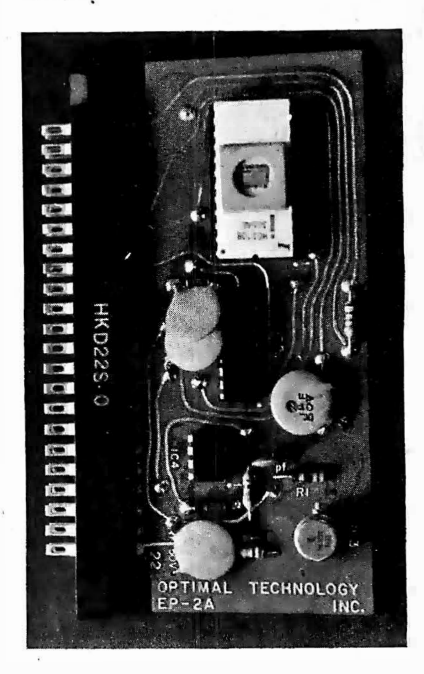
Single Sided Wire Wrap Boards in Metric Sizes



Single sided integrated circuit pluggable wire wrap boards are available in metric dimensions from Garry Manufacturing Company, 1010 Jersey Av, New Brunswick NJ 08902. Both single sizes (series SMP64) and double sizes (series DMP64) are included in the new line. The SMP64 accommodates 20 16 position integrated circuit chips while the DMP64 size will accept 55 16 position integrated circuit chips. The boards are supplied with either 16 position molded sockets or 16 position patterns of individual socket/terminals for maximum heat dissipation. They are designed to provide wire wrapping terminals on the component side, allowing the wire wrap boards to be spaced interchangeably with standard printed circuit board rack assemblies. The boards are supplied with or without a 64 position right angle IO connector (Garry P/N MPS64-PD). They are available at prices ranging from $2 to $3 per integrated circuit socket position.■

Circle 647 on inquiry card.

2708 and 2716 EROM Programmer for KIM-1



Optimal Technology Inc, Blue Wood 127, Earlysville VA 22936, announces a programmable read only memory programmer for the KIM-1 microcomputer with provisions for programming both the 2708 and 2716 (5 V only) EROMs. By using the KIM-1 monitor, any programmable memory starting address may be specified up to 65 K. Additionally, any starting address within the address space of the programmable read only memory may be specified along with the number of bytes to be programmed. The programmer has a verify mode which confirms that all bits have been programmed correctly. Completely assembled and tested, the programmer is packaged on a single printed circuit board and the connector is furnished. The program will run on all computers which utilize the MOS Technology 650X microcomputer. One and a half IO ports are required. Price is $59.95.■

Circle 648 on inquiry card.

New Soldering Flux

The flux is called Spec-Master and is available as a liquid, cored solder, paste solder and soldering paste. It is intended for use where a perfectly clean and safe residue is necessary after only a mild water wash. According to the company, the flux is available in strengths strong enough to solder stainless steel yet safe enough to yield electronically clean surfaces after water washing. It is said to be nonflammable, nontoxic, nonirritating and nonfuming. For further information write: Nokorode Soldering Products Division, M W Dunton Company, POB 6205, Providence RI 02940.■

Circle 649 on inquiry card.

POLY PAKS

COMPUTER PERIPHERAL & PARTS WORKSHOP

MAIL ORDER

POLY PAKS INTRODUCES THE FIRST MAGAZINE RETAIL STORE FOR THE ELECTRONIC MAIL-ORDER HOBBYIST!

"RED" LED READOUTS!

as low as **20¢ each**

Cat. No.	Size	Description	Sale
□ 7S1890	.127"	MAN-3**	5 for $1.00
□ 7S1503	.19	MAN-4*	2 for $1.19
□ 7S1273	.27	MAN-1*	$1.00
□ 7S3093	.33	MAN-72 equal*	$1.19
□ 7S3161	.33	MAN-74 equal**	$1.19
□ 7S3512	.35	FND359**	$1.00
□ 7S2949	.5	FND500*	$1.50
□ 7S2950	.5	FND507*	$1.50
□ 7S3483	.5	727-Dual**	$2.50
□ 7S2485	.5	727-Dual*	$2.50
□ 7S2256	.6	747*	$1.95

*Common Anode **Common Cathode

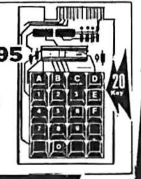
HEXADECIMAL MICROPROCESSOR AND CONTROL KEYBOARD KIT! □ 34.95

Wt. 2 lbs.

Address microprocessors, control computer operated equipment. 2 key rollover. Has 20 keys, 16 encoded, 4 external to be assigned by user. Output 4 bit binary. Also, an EXCLUSIVE FEATURE...4 leds display the binary output. TTL/CMOS compatible, requires +5, -12VDC. Complete kit! Nothing else to buy! With instructions.

- 4 bit binary/hexadecimal output plus strobe!
- New! Improved design! Saves you time!
- Keyboard pre-assembled onto PC board!

Cat. No. 7S5009 Hexadecimal Kit $34.95
Cat. No. 7S5010 Hexadecimal Wired $39.95



POLY PAKS SPECIAL

BUY $15 WORTH Take 10% DISCOUNT

BUY $100 WORTH Take 25% DISCOUNT

FROM THIS AD ONLY

$65. NEW KEYBOARD & ENCODER KIT

• Uses Encoder MOS ROM • 7 "LED" test feature

Cat. No. 7S5001 Kit $69.95
Cat. No. 7S5002 Wired $75.00

Outputs standard 7 bit ASCII; interfaces with most data systems. Keyboard pre-assembled onto PC board. 2 key rollover. Electronic shift lock and carriage return. 4 modes: Normal, control, shift, shift/control. Additional functions can be assigned by user. +5, -12VDC. 200 ma. Negative or positive logic, jumper selectable. Exlcusive test feature...7 LED's display the ASCII code. Complete kit, nothing else to buy! Size: 13" x 5 1/2 x 1 1/4". 3 lbs.

- Uses MOS Encoder ROM!
- 7 LED Test Feature!
- 64 key keyboard!
- Encodes 128 ASCII Characters
- Interfaces with ALTAIR, IMSAI, and more!

MICROPROCESSORS! MEMORIE$! SUPPORT!

Order by Cat. No. 7S3459 and type

Type	Description	Sale
□ MC6800L	8 bit CPU	$19.95
□ 8080A	8 bit CPU, 2 usec	11.95
□ Z80A	8 bit CPU	24.95
□ 8008	CPU	9.95
□ 1101	256 x 1 stat. RAM	.69
□ 1103	1K Dyn RAM	1.29
□ 1702A	256 x 8 EPROM	5.95
□ 2102-L1	1K x 1 Lo-power RAM	1.69
□ 2111	256 x 4 Stat. RAM	5.95
□ 2708	8K EPROM	10.95
□ MK4116	16K Dyn RAM	29.95
□ MK4200P11	4K x 1 Dyn RAM, 350nsec	3.95
□ MM5202	2K PROM	6.95
□ MM5203	2K EPROM	8.95
□ MM5260	1K Dyn RAM	.99
□ MM5262	2K x 1 Dyn RAM	.99
□ 8212	8 bit I/O port	3.95
□ 8216	Bi-direct bus driver	3.95
□ 8224	Clock Gen	4.95
□ 8228	System cont.	9.95
□ 8251	Communication int	11.50
□ 8255	Periph inter	11.95

DISCRETE LED'S 6 for $1.19

Order in multiples of 6 of each type!

□ JUMBO .34" h
□ MEDIUM .24"
□ MICRO .21" (TO-18)

Cat. No.	Description	Similar to
□ 7S2135	Jumbo Red	MV5053
□ 7S1944	Jumbo Yellow	XC556Y
□ 7S2138	Jumbo Green	XC556G
□ 7S2785	Medium Red	XC22
□ 7S2788	Medium Green	XC22G
□ 7S2137	Micro Red	XC209
□ 7S1948	Micro Yellow	XC209Y
□ 7S2140	Micro Green	XC290G

COMPUTER GRADE CAPACITORS

Order by Cat. No. 7S5112 and value!

Mfd	WVCD	Sale
□ 8,000	50	$2.75
□ 13,000	40	2.25
□ 14,000	50	2.75
□ 15,000	12	1.50
□ 22,000	75	3.95
□ 24,000	30	2.50
□ 44,000	30	3.95

FULL WAVE BRIDGE RECTIFIERS!

PIV	2 AMP (#7S1346)	6 AMP (#7S2456)	10 AMP (#7S2447)	25 AMP (#7S2273)
□ 50	$ .59	$ .88	$1.05	$1.20
□ 100	.65	.99	1.15	1.25
□ 200	.69	1.19	1.29	1.95
□ 400	.89	1.40	1.79	2.95
□ 600	.99	1.69	1.95	3.95
□ 800	1.19	1.95	2.25	4.95
□ 1000	1.25	2.25	2.50	5.50

Orer by Cat. No. Amperage and Voltage

SPECTRA-TWIST RIBBON CABLE

• Twisted pairs of brightly colored cable! 24AWG

□ Cat. No. 7S3680 48 cond. 2 ft. $1.98
□ Cat. No. 7S4081 32 cond. 2 ft. $1.98

RIBBON CABLE AT THIN PRICES

- Ultra-flat! • 28 AWG!
- Single color! Indexed!

Cond.		Sale
□ 20	8 ft.	$1.98
□ 26	6 ft.	$1.98
□ 34	5 ft.	$1.98
□ 40	4 ft.	$1.98
□ 50	3 ft.	$1.98

Order by Cat. No. 7S3939 and conductors

Low Power ICs

Order By Cat. No. 7S3667 & Type No.

Type	Sale	Type	Sale
□ 74LS00	$.32	□ 74LS132	1.19
□ 74LS02	.32	□ 74LS138	1.24
□ 74LS04	.35	□ 74LS139	1.24
□ 74LS08	.32	□ 74LS151	1.25
□ 74LS10	.32	□ 74LS153	1.25
□ 74LS11	.32	□ 74LS155	1.25
□ 74LS13	.64	□ 74LS160	1.47
□ 74LS20	.32	□ 74LS161	1.47
□ 74LS21	.32	□ 74LS162	1.47
□ 74LS22	.32	□ 74LS163	1.47
□ 74LS27	.39	□ 74LS168	1.68
□ 74LS30	.32	□ 74LS169	1.68
□ 74LS32	.39	□ 74LS173	1.68
□ 74LS37	.45	□ 74LS174	1.05
□ 74LS38	.45	□ 74LS190	1.77
□ 74LS42	1.19	□ 74LS191	1.75
□ 74LS47	.99	□ 74LS192	1.75
□ 74LS74	.49	□ 74LS193	1.75
□ 74LS90	.89	□ 74LS195	1.25
□ 74LS92	.89	□ 74LS197	1.25
□ 74LS93	.89	□ 74LS257	1.35
□ 74LS109	.58	□ 74LS266	.54
□ 74LS112	.58	□ 74LS366	.66
□ 74LS113	.58	□ 74LS368	.69
□ 74LS114	.49	□ 74LS390	2.95

C-MOS

Order By Cat. No. 7S2320 & Type No.

Type	Sale	Type	Sale
□ CD4000	$.29	□ CD4022	1.19
□ CD4001	.29	□ CD4023	.29
□ CD4002	.29	□ CD4024	.79
□ CD4006	1.19	□ CD4025	.34
□ CD4007	.29	□ CD4027	.69
□ CD4008	.79	□ CD4028	.89
□ CD4009	.58	□ CD4029	1.19
□ CD4010	.59	□ CD4030	.49
□ CD4011	.28	□ CD4033	1.60
□ CD4012	.29	□ CD4035	.99
□ CD4013	.69	□ CD4040	1.19
□ CD4 05	1.19	□ CD4041	1.25
□ C D0 16	.49	□ CD4042	.88
□ CD4017	1.19	□ CD4046	1.79
□ CD4018	1.19	□ CD4049	.49
□ CD4019	.49	□ CD4066	.79
□ CD4020	.99	□ CD4071	.29
□ CD4021	1.29		

SILICON POWER STUD RECTIFIERS!

Order by Cat. No. Amperage and voltage.

PIV	12 AMP (#7S727)	50 AMP (#7S727)	250 AMP (#7S685)
□ 50	$ .29	$ .75	$4.95
□ 100	.36	1.10	6.50
□ 200	.45	1.35	7.50
□ 400	.61	1.75	8.50
□ 600	.79	2.25	10.50
□ 800	.90	2.75	11.50

TTL'S

Type	Sale	Type	Sale
□ SN7400	$0.14	□ SN7472	.26
□ SN7401	.14	□ SN7473	.31
□ SN7402	.17	□ SN7474	.31
□ SN7403	.14	□ SN7475	.48
□ SN7404	.17	□ SN7476	.39
□ SN7405	.18	□ SN7483	.69
□ SN7406	.19	□ SN7485	.88
□ SN7407	.24	□ SN7486	.29
□ SN7408	.18	□ SN7490	.69
□ SN7410	.14	□ SN7492	.45
□ SN7411	.19	□ SN7493	.45
□ SN7413	.39	□ SN74107	.29
□ SN7414	.61	□ SN74121	.31
□ SN7417	.24	□ SN74123	.49
□ SN7420	.14	□ SN74125	.39
□ SN7427	.26	□ SN74132	.83
□ SN7430	.14	□ SN74145	.89
□ SN7432	.24	□ SN74151	.63
□ SN7437	.24	□ SN74153	.63
□ SN7440	.14	□ SN74154	.99
□ SN7441	.79	□ SN74157	.64
□ SN7442	.49	□ SN74161	.87
□ SN7445	.69	□ SN74164	.95
□ SN7446	.79	□ SN74174	.93
□ SN7447	.79	□ SN74175	.88
□ SN7448	.75	□ SN74181	1.95
□ SN7450	.14	□ SN74190	1.15
□ SN7451	.14	□ SN74191	.99
□ SN7470	.28	□ SN74192	.83
		□ SN74193	.83
		□ SN74195	.75
		□ SN74251	1.39

HANDY COMPUTER MULTITESTER



- 1000 ohms per volt

1% precision, movements diode protected against burnout. Measures DC volts 0-15-150-1000; AC volts 0-15-150-1000; DC current 0-150ma; resistance X1000. Sensitivity 1000 ohms/volt AC-DC. Uses penlite cell, not included. Size 2 3/8 x 3 1/2 x 1 3/8". Wt. 5 ozs.
Cat. No. 7S3921

POLY PAKS "CHIPS" AWAY IC AND CRYSTAL PRICES!

Order by Cat No. 7S4048 and Type No!

Type	Description	Sale
□ ICM7205	Stopwatch	$14.95
□ AY3-8500-1	6 TV Games	9.95
□ MM5330	4½ Digit DVM	4.95
□ 8038C	Volt Control Osc.	4.95
□ KR2376-139	BCD Encoder Rom	6.95
□ KR2376-ST	ASCII Encoder Rom	14.95
□ 11C90DC	650MHz Prescaler	14.95
□ 95H90DC	350MHz Prescaler	8.88
□ MC14410	Touch Tone Chip	9.95
□ MK2002P	Char Gen. (sim 2513)	3.95
□ 7207A/7208	Freq Counter pair	24.95
□ ICM7107	3½ Digit DVM/DMM	12.50
□ MM5369	60 Hz Timebase IC	1.95
□ 3.579MHz	Timebase Xtal	1.95
□ 1.00MHz	Touchtone Xtal	5.95
□ 3.2768MHz	Stopwatch Xtal	4.95

DIP SWITCHES

Cat. No.	Switches	Sale
□ 7S 3668	2	$.77
□ 7S 3669	3	.86
□ 7S 3021	4	.99
□ 7S 3670	5	1.19
□ 7S 3671	6	1.29
□ 7S 2677	7	1.79

EECO 10-POSITION BCD THUMBWHEEL SWITCH

1-2-4-8 BCD encoding! Positions labeled 0-7, F, L. (F coded for 8. L coded for 9). White numerals on a black background. Eeco 80 0 series. 1 1/4 x 1 1/4 x 1/2". Cat. No. 7S3846 3 for $4. □ $1.49

LINEARS

Type	Sale	Type	Sale
□ LM301H, V	$.25	□ LM380N	1.19
□ LM307H, V, N	.25	□ LM381N	1.19
□ LM308H, V	.79	□ LM555V	.44
□ LM309K	1.19	□ LM558V	.69
□ LM311H, V	.79	□ LM565N	.65
□ LM320T-5V	1.19	□ LM567V	1.40
□ LM340T-5V	1.19	□ LM703H	.39
□ LM340T-12V	1.19	□ LM709H, N	.22
□ LM340T-15V	1.19	□ LM710N	.29
□ LM340K-5V	1.19	□ LM723N	.42
□ LM340K-12V	1.19	□ LM741H, V, N	.29
□ LM340K-15V	1.19	□ LM747H, N	.59
□ LM322N	1.19	□ LM1458V	.69
□ LM324N	.99	□ LM1800N	1.49
□ LM339N	1.09	□ LM3900N	.35
□ LM377N	1.50	□ LM39009V	1.19
□ LM379N	4.95	□ LM75491	.69
		□ LM75492	.75
		□ PA263	1.50

GIANT SALE! MICRO-MINI TOGGLE SWITCHES

- 3A, 125VAC contacts or better
- Complete with mounting hardware! *Center off

Cat. No.	Contacts	Sale
□ 7S3936	SPST	$1.19
□ 7S4036	SPDT	1.29
□ 7S5085	SPDT*	1.39
□ 7S4037	DPDT	1.45

IC SOCKETS

as low as **17¢** ea.

- Low profile, solder tail.

□ 7S2123 8 pin minidips .17
□ 7S1308 14 pin dip .19
□ 7S1309 16 pin dip .22
□ 7S3378 18 pin dip .25

WOW!

"MICRO-TONE" AUTOPATCH ENCODER KIT 26.88 □

Only 2 1/8 x 1 5/8 x 1/2", small enough to mount in a mike! Snap action bubble keys contact. Features output level control, xtal controlled digitally synthesized tones, on-chip oscillator. Requires 4.5 to 5.5 VDC. Complete kit! Nothing else to buy! Wt. 12 oz.

- Complete in its own mini-cabinet!
- Family!
- Friends!
- Emergency!

Cat. No. 7S4086 kit $26.88
Cat. No. 7S4087 wired $32.95

COMPUTER GRAPHICS "JOYSTICK"

2 for $8. □ $4.50

- Four 100K pots!
- Chrome handle and knob!

Wt. 10 oz. Cat. No. 7S3808A

SPECTROL "SKINNY-TRIMS" 2 for $1

3/8" square, screwdriver shaft. 2% tol. 1/4 watt. Cermet. PC leads. Order by Cat. No. and value.

□ No. 7S3863 25 turn upright, type 64
□ No. 7S3866 single turn, flat, type 63

Ohms	
□ 10**	
□ 50**	
□ 100**	□ 5K*
□ 200**	□ 10K*
□ 500*	□ 20K**
□ 1K*	□ 50K**
□ 2K**	□ 100K**

*Available in all types
**Available in Cat. No. 3863 only.

MOTHERBOARD EDGE CONNECTOR

□ $2.50

106 pins (53 each side). Use with IMSAI & ALTAIR! 0.125" pin ctrs, goldplated 5/8" wire wrap leads. Open ends, fit wide PC boards. 8 ozs. Cat. No. 7S3987

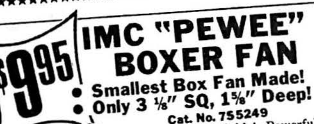
TRANSFORMER SALE



• 110VAC Primaries

Cat. No.	Output V.	Amps		Sale Each
□ 7S 3399	6.3V	500ma	Metal encased	$1.98
□ 7S 3814	6.3V	1A	Open frame	$2.49
□ 7S 3412	12V	300ma	Open frame	$1.95
□ 7S 4029	12V	1A	Open frame	$2.49
□ 7S 3875	110V	300ma	Isolation	$1.19

IMC "PEWEE" BOXER FAN



- Smallest Box Fan Made!
- Only 3 1/8" SQ, 1 5/8" Deep!

Cat. No. 7S5249



Quiet! Dependable! Powerful! Delivers 36 cfm Scarcely Audible Noise Level! Sleeve bearings rated for 10 years life! Perfect for cooling, ventillation, heating: for computers, power supplies, hi-fi eqpt, light projectors & more. 7-Blade flame-retardant polycarbonate fan, housed in die cast aluminum block. Wt. 1 lb.

For Hi-Fi and Computers. 115 VAC!

10 AMP POWER TAB SCR'S, TRIACS, QUADRACS!

Order by Cat. No. and Voltage

	Cat. No.
SCR'S	7S1730
TRIACS	7S1448
QUADRACS	7S1590

PIV	SALE
□ 50	$.55
□ 100	.69
□ 200	.88
□ 400	1.19
□ 600	1.59

1N4000 Epoxy Rectifiers

• Miniature! • 1.5 Amp!
Order by Cat. No. and Type No.

Cat. No.	Type No.	PIV	Price
□ 7S 2377	1N4001	50	10 for $.65
□ 7S 2378	1N4002	100	10 for .75
□ 7S 2379	1N4003	200	10 for .85
□ 7S 2380	1N4004	400	10 for .99
□ 7S 2381	1N4005	600	10 for 1.29
□ 7S 2382	1N4006	800	10 for 1.39
□ 7S 2383	1N4007	1000	10 for 1.49

WRITE FOR POLY PAKS 1978 CATALOG

FREE!

FEATURING:

- Computer Components!
- Over 400 Assortments!
- Digital Clocks, DPM's, and Stopwatches!
- Hi-Fi Stereos-Speakers!
- Solar Energy! Semi's!
- Test Equipment!
- Fiber Optics! Plus More n' More!

Terms: Add postage. Rated: net 30
Phone: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield,

MINIMUM ORDER — $6.00

POLY PAKS®

C.O.D.'s MAY BE PHONED

P.O. BOX 942-S7
LYNNFIELD, MA.
ZIP 01940

Circle 303 on inquiry card.

Circle 353 on inquiry card.



$199.95
AS IS

$249.95
WORKING & CLEANED

IBM® Selectric-Based I/O Writers Excellent Hobby Printers

Series 72/731	All Solenoids
Heavy Duty	Original Documentation
8½" Platten	While Supply Lasts

SUPER SALE

These terminals are from a large airline reservation system. They are heavy duty and were under continuous maintenance. The units have been in storage. We make every effort to ensure that all essential parts are included. Most work when plugged in. No warranties are given or implied.

Conversion Kits.

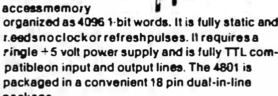
1. Conversion instructons, P C board for printer only using software approach $59.95
2. I/O kit makes the unit into a conversational terminal. Instructions, P C board, components for a parallel or RS232 interface. Will work with any IBM terminal $249.95
3. Completely converted unit and assembled interface for I/O using kit $999.95

Card reader by HP with RS232 interface	$299.95
Printec line printers, parallel interface	$1500.00
Honeywell 516 & 316 mini's, make offer. Cables, used 11 conductor, 100 ft with connectors	$9.99
Electronic parts and circuit boards 1/4 lb bag	$4.99

Check, Money Order, Cash. Personal checks require 3 weeks to clear. No COD's. Units shipped UPS or PP collect. Prices Net FOB Tulsa

SUPER SURPLUS SALES
P.O. BOX 45944 TULSA, OK 74145 1-918-622-1058

4801 STATIC, TTL IN/OUT 4096x1 N-MOS RAM



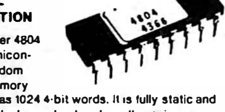
GENERAL DESCRIPTION

Part Number 4801 is a 4K semiconductor random accessmemory organized as 4096 1-bit words. It is fully static and needs no clock or refresh pulses. It requires a single +5 volt power supply and is fully TTL compatibleon input and output lines. The 4801 is packaged in a convenient 18 pin dual-in-line package.

FEATURES

- Single +5V Power Supply
- 4Kx1 Organization
- Replaces 4 1024x1 Static RAMs
- Completely Static—NoClocks or Refresh
- 18 Pin Package
- Access/Cycle Times 600 nsec max
- 250 mw Typical Operating Power
- Separate Data In and Data Out
- TTL Compatible I/O
- Three State Outputs
- Data Bus Compatible I/O Function

4804 STATIC, TTL IN/OUT 1024x4 N-MOS RAM



GENERAL DESCRIPTION

Part Number 4804 is a 4K semiconductor random access memory organized as 1024 4-bit words. It is fully static and needs no clock or refresh pulses. It requires a single +5 volt power supply and is fully TTL compatible on input and output lines. The 4804 is packaged in a convenient 18 pin dual-in-line package.

FEATURES

- Single +5V Power Supply
- 1Kx4 Organization
- Replaces 4 1024x1 Static RAMs
- Completely Static—No Clocks or Refresh
- 18 Pin Package
- Access/Cycle Times 600 nsec max
- 250 mw Typical Operating Power
- Common I/O Bus
- TTL Compatible I/O
- Three State Outputs

4801 or 4804 4K RAM's

$8.95 8/$60.00 16/$100.00



tri-tek, inc.
7808 North 27th Avenue
Phoenix, Arizona 85021
(602) 995-9352

Signetics 2504TA 1024 bit S.R. memory (1404A)...	.50
MCM 6671P Character Generator	9.95
MCM6571AP Character Generator	9..95
MC14409P Telephone Rotary Pulser	10.98
MC14419P Touch Pad Converter for 14409	4.25
MC14411P Baud Rate Generator	11.98
MC14412VP CMOS Modem Chip	16.95
MM57109N Number Cruncher Micro	18.95
74C915 7 Segment to BCD Converter	2.99
74C922 16 Key Keyboard Encoder	6.35
74C923 20 key Keyboard Encoder	6.45
74C925 4 Decade Counter w/latches	12.00
74C926 4 Decade Counter w/carry	12.00
74C935-1 3½ Digit DVM CMOS Chip	16.98
IN4003 200 V 1 amp	12/$1.00
IN4004 400 V 1 amp	10/$1.00
IN4148 Hi Speed Signal	15/$1.00 100/$5.00
D-600 115 V, 100 mA Hi Speed Signal	20/$1.00
D2131 200 V, 25A Stud	85¢
D2135 400 V, 25A Stud	1.00
D2138 600 V, 25A Stud	1.55
D3289R 200 V, 160A Stud Anode	5.85
D3909-4 50 V, 45A Fast Recovery	2.00
IN4732A-47A 1W 5% Zeners	4/$1.00
13 Assorted *Brand New* Zener Diodes	1.00
50V 3 amp Epoxy Bridge	79¢
200V 30 amp Bridge	2.00
600V 4 amp Epoxy Bridge	1.49
600V 3 amp Stud Bridge	.89
SI-2 200V, 1.5A Gold Leads	15/$1.00
D1A-0030 30V DIAC	10/$1.00

VOLTAGE REGULATORS

7805-06-08-12-15-24TO220	95¢ 5/$4.50
78LO5A-12-15 4% 100 mA TO-92 Plastic	50¢
78HO5KC 5V 5A TO-3	9.15
78H12KC 12V 5ATO-3	9.15
78H15KC 15V 5A TO-3	9.15
Lm317K 1.5A *Adjustable* TO-3	4.99
Lm317T 1.5A *Adjustable* TO-220	3.99
Lm317MP .5A *Adjustable* TO-202	13.95
TL430C Adjustable Zener-*Think About It*	1.50
TL497C Switching Reg. & Inductor	9.50
RCA CA 3085 100 mA *Adjustable*	.60

- Please give street address for UPS shipping when possible.
- C.O.D. NO parcel post C.O.D. UPS C.O.D. Add 85¢ to order.
- Any correspondence not connected with your order, please use separate sheet and include SASE for reply.
- Orders less than $10 ($15 foreign) please add $1 handling.
- Prices are subject to change without notice.
- Any refunds will be by check, not credit vouchers.
- Terms. Check, money order, credit card. Net 30 days to rated firms, schools and government agencies.
- If we should be temporarily out of stock on an item, it will be placed on back order. If we cannot ship in 30 days, you will be notified of the expected shipping date and furnished with a postage paid card with which to cancel your order if desired.
- We pay surface shipping only in USA, Canada and Mexico.
- For premium shipping (first class, special handling, etc.) add extra. [illegible] will be refunded.
- Foreign orders (except Canada and Mexico) estimate and add shipping. Excess will be refunded.

INTEGRATED TONE RECEIVER MK5102(N)-5

FEATURES

- ☐ Detects all 16 standard DTMF digits
- ☐ Requires minimum external parts count for minimum system cost
- ☐ Uses inexpensive 3.579545 MHz crystal for reference
- ☐ Digital counter detection with period averaging insures minimum false response
- ☐ 16-pin package for high system density
- ☐ Single supply 5 Volts ± 10%
- ☐ Output in either 4-bit binary code or dual 2-bit row/column code
- ☐ Latched outputs

DESCRIPTION

The MK5102 is a monolithic integrated circuit fabricated using the complementary-symmetry MOS (CMOS) process. Using an inexpensive 3.579545 MHz television colorburst crystal for reference, the MK5102 detects and decodes the 8 standard DTMF frequencies used in telephone dialing. The requirement of only a single supply and its construction in a 16-pin package make the MK5102 ideal for applications requiring minimum size and external parts count.

DETECTION FREQUENCY

Low Group f_o	High Group f_o
Row 1 = 697 Hz	Column 1 = 1209 Hz
Row 2 = 770 Hz	Column 2 = 1336 Hz
Row 3 = 852Hz	Column 3 = 1477 Hz
Row 4 = 941 Hz	Column 4 = 1633 Hz

JULY SPECIAL 'TIL 31 JULY
MK5102N-5......................$33.00
Spec.............................. .40
600 :600 C.T. phone transformer...$1.50

P. C. BOARD TERMINAL STRIP

Molded body encloses positive screw activated clamp which will accomodate wire sizes 14–30 AWG. Contacts and pins are solder plated copper. Pins are on .200 inch (5.08mM) for standard P. C. mounting. 10Amp rating. Compare our prices before you buy.

4 pole	TS-2504	.99
8 pole	TS-2508	1.49
12 pole	TS-2512	2.19



Circle 381 on inquiry card.

Unclassified Ads

TRADE: BYTE, volume 1, number 2, good condition; for Dr Dobb's Journal of Computer Calisthenics and Orthodontia, volume 1, number 1; I need the article on NIBL BASIC for the SC/MP chip. Joe Price, POB 543, Olton TX 79064.

FOR SALE: TRS-80 LEVEL-I BASIC tapes and lists: Star Trek (needs 12 K memory), list $7, tape $9.95: Biorhythm (4 K), list $4.50, tape $7: Lunar Lander (4 K), list $3, tape $5. R Menzies, 7106 Colgate Dr, Alexandria VA 22307.

FOR SALE: ASR 32 Teletype with stand, paper tape punch and reader, documentation; excellent condition, $325. David Shorthill, RFD #2, Wells ME 04090, (207) 646-5465.

TERMINAL: Texas Instruments 725, 30 cps, hard copy, built in modem and coupler, rugged portable case. Very quiet, popular professional terminal, $775 plus shipping. Also memory: Solid State Music, 8 K, static, 500 ns (no waits), assembled, works, $150, Wright, POB 7576, Menlo Park CA 94025 (415) 854-5678.

FOR SALE: Heathkit computer system. System includes: H8 computer, H9 video terminal, 8 K memory, all standard Heathkit software plus extended BASIC. Completely assembled and tested. Asking $1400. Call or write Paul Randazzo, 37 Maxwell Dr, Wethersfield CT 06109 (203) 529-0530.

WANTED: Back issues of CACM, JACM, and JCCs. W Hutchison, Princeton Arms N 191, Cranbury NJ 08512.

FOR SALE: Shugart SA400 minifloppy disk drive and ten minifloppy disks, $390, (no controller or power supply). Working video interface per February 1976 BYTE, $100. DECwriter keyboard, $50. Power supply, $35. Case, $42. Parts for 6800 processor board including 6800, 2x6810, 2x6820, 2708, wire wrap sockets and support ICs $150. Everything except disk, $310. James Thomas, POB 26, Sandy Spring MD 20860, (301) 774-7686.

FOR SALE: DEC PDP8e modules and peripherals DKBEP, $375. AD8 16 channel A/D $875. DECwriter $1050. Omnibus expanders, power supplies, KLBEs; lots more. Send for list and tell me if you have anything for trade or sale. I will repair any DEC part or build custom interfaces or modules. J Simpson, POB 632, W Caldwell NJ 07006.

FOR SALE: Thinker Toys "Speakeasy" board assembled, RS-232 serial port used, $100. Paul Lamb, 13101 Parson Ln, Fairfax VA 22030.

FOR SALE: The Northstar Users group has over 230 outstanding programs including real estate, investment, business, debugging aids and games. I will copy these public domain disks for $5 per disk plus the cost of a disk (or send a disk). About 15 programs on each disk. For a list of programs and details send SASE to J Dvorak, 704 Solano Av, Albany CA 94706, (415) 527-7730.

Readers who have equipment, software or other items to buy, sell or swap should send in a clearly typed notice to that effect. To be considered for publication, an advertisement should be clearly noncommercial, typed double spaced on plain white paper, and include complete name and address information. These notices are free of charge and will be printed one time only on a space available basis. Insertions should be limited to 100 words or less. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine. ■

FOR SALE: Floppy Tape Peripheral: complete with IO board, 8 tapes, new and used. Uses stereo 8 track cartridge. Each cartridge can hold one program per track or 8 per cartridge. Program length limited only by tape length. The used tapes have 5 or 6 programs on each and are included free. They are ready to run and cover *Star Trek*, *Othello*, other games and technical programs. Will interface to most microcomputers, schematic included. Will ship UPS. $100. R Mendelson, 27 Somerset Pl, Murray Hill NJ 07974, (201) 464-5244.

FOR SALE: Teletype model 33ASR, Excellent condition, $600. ALTAIR 8080a, with 8 K memory, TTY and cassette IO boards. Factory perfect condition, all MITS, $580. Selectric based typewriter with paper tape RDR/PCH. Nice TTY alternative, $480. All for $1500 Andrew Frankford, 2014 Marietta Av, Lancaster PA 17603, (717) 299-2456.

TELETYPE FOR SALE: (All 8 level ASCII) Model 33ASR (new), $1000. Model 35KSR (new), $1500. Model 35ASR (used, very good), $1500. Model 35 reperf and reader set, $425. Parts for Model 33 and 35 machines, gears, modems. Model 28 Baudot machines. Send SASE for complete list and prices. Lawrence R Pfleger, 2141 N 52nd St, Milwaukee WI 53208.

PROGRAM EXCHANGE: Programs are now available, in source form, to run on most any home microcomputer. These programs come from various sources and are written in BASIC and other languages. In addition, our club needs other programs that you may have developed, making them available to other hobbyists for fun, enjoyment, and practical use. If you can make available such programs we want to hear from you. Please write to us soon. For complete descriptive literature and a list of currently available programs, send $1 to cover copy and mailing costs to: Mikel Home Computing, POB 17105, Irvine CA 92713.

FOR SALE: "Elf" microcomputer trainer, $60 complete. Built from Popular Electronics articles. Carefully wire-wrapped on Vector board; all ICs socketed. Full hexadecimal keyboard in outboard module. Hexadecimal display shows IO byte and memory address. All modifications fully documented. RCA User's Manual, article reprints, much extra data included. Bob Levine, 32 King St, New York NY 10014.

FOR SALE: MMD-1 by E&L Instruments, $250, Bug Book V included (6 units). Contact (805) 522-5276, after 6 PM.

FOR SALE: BYTE September 75 through December 76 excluding January 76. All in perfect condition. Make an offer. Fred Henry, 104 Heathercreek Dr, Plainfield IL 60544, (815) 436-6111.

FOR SALE: North Star BASIC programs: Correspondence Editor: $5, Stock Market Analysis package: $5, Mailing list and random access package: $3, Spacewar game package: $3, plus: Stock Market data on 30 heavily traded companies on North Star disk. Includes: P/E, price, volume, and percent yield, weekly averages for 1977: only $25 for all 30. Send blank disk, or include $5.25 for disk. Write for complete list. Herbert Schildt, 1007 N Division, Urbana IL 61801.

TRADE: 12 slot ALTAIR 8800A with HD power supply plus 10 slot IMSAI for factory assembled Altair 8800B. Both units fully socketed and factory checkout. Ken Roberts, 10560 Main, #515, Fairfax VA 22030. (703) 591-6008 or (703) 378-7266.

FOR SALE: PORTACOM briefcase ASCII printing terminal w/modem, keyboard, instructions, $596. DEC PDP8es, modules, ASR33s, ham gear, free lists, buy, trade, repair, design also. K2DCY, 11 Squire Hill, N Caldwell NJ 07006.

FOR SALE: Digital Group Z-80 four board system including CPU, IO, TV cassette and mother board assembled. Two 8 K memory boards, one with ICs, both with sockets, unassembled. Complete assembly plans and documentation. Going to college, must sell. $750. Richard Yero, 12323 Algonquin Rd, Palo Park IL 60464 or call (312) 448-2609 after 4:00 PM or weekends.

FOR SALE. Altair 8800a with IMSAI 20A power supply installed in original cabinet. With serial IO board, Tarbell 1702A prom board, and 4 to 32 K programmable memory. Everything works 100% and software is included. Tell me what you want and I will quote a price, or make me an offer. For more information call (518) 456-8717 or send SASE to Michael Favitta, 4 Sherwood Forest Rd, Albany NY 12203.

FOR SALE. NCR high speed paper tape punches, 110 V, 60 Hz, used but overhauled about 100 cps (according to technical manual), self-contained cabinet, tape spooling mechanism built-in, eight tracks, weight 40 lbs. Delivery within 5 weeks after your order comes in (ie: 5 weeks till you have it). Price $200 including freight, collective orders from clubs (minimum 5 punches) $150 per punch plus $100 for freight. Order accompanied by crossed checks should be sent to TIME OUT, Siegfried Manfred Rambaum, Rossdoerfer 44, 6100 Darmstadt, GERMANY.

FOR SALE: Control Data 200 UT remote batch/interactive terminal, equipped with a 14 inch CRT, 63 character keyboard, 300 CPM card reader, 300 LPM-136 column line printer and 4800 baud communications capability. Complete original service and operation documentation included. Excellent condition, currently under CDC maintenance contract. Contact: Bob Levy or Bob Minor (301) 565-9544 8750 Georgia Av, Silver Spring MD 20910.

FOR SALE: Motorola MEK6800D2 evaluation kit, 8 K Solid State Music Memory board. Includes 4 slot Altair (S-100) extender board, cabinet, 5 V 6 A power supply, Mik-Bug firmware, 8 K (SwTPC) BASIC, 8 K (SwTPC) Text Editor and Assembler, 4 K Tiny Assembler, PCC's BASIC games, (the evaluation module has an integral Keyboard/Cassette interface) and COMPLETE SYSTEMS/Family Documentation. Must selll Asking $350 – will take best offer. Amn Trotz, Psc Box 1116, Wurtsmith AFB MI 48753.

FOR SALE: Lunar Landing simulation program for any Radio Shack TRS-80 computer. On cassette, ready to load. Send check or money order for $7.50 to J Quistgaard, 715 S Alder St, Port Angeles WA 98362.

FOR SALE: Heathkit H-9 video terminal, expertly assembled, $600. Also, box of ten 8 inch Data Packaging (DPI) floppy disks, never used, $50. I pay shipping. Andy Thornburg, 400 E Jackson St, De Soto IL 62924.

WANTED: Card extender or connector (male and female ELCO PN00-7015-059-000-002) for DATA POINT 3300-101 59 pin. Cecil T Rutledge, 2726 Sandy Ln, Fort Worth TX 76112.

FOR SALE: Altair 8800B computer with 32 K 200 ns static programmable memory, two serial ports, one parallel port, PROM board, ACR cassette interface, floppy disk drive and controller, panel mounted baud rate switches for fast device change, extended BASIC on cassette, disk extended BASIC, and DOS, along with 30 floppy disks, $5000, Steve Mastrianni, 2952 Main St, Coventry CT 06238. (203) 742-6727 or (203) 664-2401.

Apple II Software cassette: 16 K Blackjack mutlicolor card display, 2 player paddle input, full Las Vegas rules, optional autoplay by computer, sound effects, documentation included, $10. George W Lee, 18803 S Christina Av, Cerritos CA 90701.

FOR SALE: All issues of BYTE from September 1975 to August 1977. All issues completely intact and in mint condition. Best offer over $60 within one month after ad's appearance. Richard Fermoyle, 7597 NW 73rd Ter, Tamarac FL 33319.

FOR SALE: One Compucolor 8001 color terminal with BASIC 8001, background color option 32 K programmable memory (8 K for CRT), floppy tape bulk storage. CPU operating system includes memory manipulation and paper tape IO subroutines. One free serial IO port. In perfect operating condition, $2995. Contact D Brown, (803) 771-6087, 1308 Shirley St, Columbia SC 29202.

VISIBLE OR INFRA RED

USED FOR CHARACTER RECOGNITION FOR COMPUTERS WITH EXTERNAL CIRCUITS

MAY BE USED IN A VACUUM, UNDER WATER, HIGH ALTITUDE

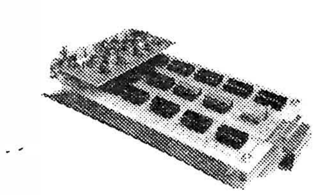
IN MAGNETIC ENVIRONMENT BECAUSE THERE IS NO HIGH VOLTAGE OR MAGNETIC DEFLECTION

MINATURE SOLID STATE

202 VIDEO CAMERA KIT

FEATURING A. . .100 × 100 BIT SELF SCANNING CHARGED COUPLED DEVICE

THIS UNIQUE UPDATED CAMERA KIT
FEATURES THE FAIRCHILD CCD 202C IMAGE SENSOR

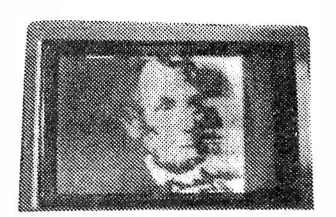


ADVANTAGES

- **IN THE FUTURE WE WILL SUPPLY A COMPUTER VIDEO INTERFACE CARD**
- All clock voltages operate at 6V reguiring no adjustments
- Higher video output signal
- We supply the power board, so only a 5V 1 Amp power source is needed
- The circuitry has been simplified for easier assembly
- Two level TTL output is supplied for interfacing

FEATURES

- Sensitive to infra red as well as visible light
- May be used for IR surveillance with an IR light source
- Excellent for standard surveillance work, because of light weight and small size
- All components mounted on parallel 3¾″ × 6½″ single sided boards
- Total weight under 1 lb.



$349.00 KIT

Add $75.00 to assemble and test

Add $2.00 Postage and Handling

We supply all semiconductors, boards, data sheets, diagrams, resistors and capacitors, and 8MM lens.
Sorry we do not supply the case, batteries and 5V supply.

SURPLUS CENTRONICS PRINTERS

101 — $1,150
306 — $900

UNIVERSAL 4Kx8 MEMORY BOARD KIT

$69.95

32-2102-1 fully buffered, 16 address lines, on board decoding for any 4 of 64 pages, standard 44 pin buss, may be used with F-8 & KIM

EXPANDABLE F8 CPU BOARD KIT

$99.00

featuring Fairbug PSU.1K-of static ram, RS 232 interface, documentation, 64 BYTE reqis.er

4K BASIC FOR FAIRBUG F8

on paper tape $25.00

C/MOS (DIODE CLAMPED)

4001 –	.18	4016 –	.29	4027 –	.37	4053 –	1.10
4002 –	.18	4017 –	.90	4028 –	.80	4055 –	1.25
4006 –	.95	4018 –	.90	4029 –	.95	4066 –	.70
4007 –	.18	4019 –	.37	4030 –	.33	4071 –	.18
4009 –	.37	4020 –	.90	4035 –	.97	4076 –	.97
4010 –	.37	4021 –	.90	4042 –	.65	4518 –	1.00
4011 –	.18	4022 –	.90	4046 –	1.35	74C10	.22
4012 –	.18	4023 –	.18	4047 –	1.50	74C193	.95
4013 –	.29	4024 –	.75	4049 –	.34		
4015 –	.74	4025 –	.18	4050 –	.34		

2708-8K EPROM (450 ns)	$ 9.75
2522 STATIC SHIFT RE6	$ 1.96
2613 CHARACTER GEN	$ 6.75
2518 HEX 32 BIT SR	$ 2.20
5203-2K EPROM	$ 4.50
2102-1 (450ns)	$ .99
21LO2-1 (450ns)	$ 1.26
MM5270-4KXI DYN	$ 3.45
MK 4008P	$ 1.95
2101-1-254 x 4 STATIC	$ 2.45
2111-1-256 x 4 STATIC	$ 3.45
2112-1-256 x 4 STATIC	$ 2.76
6280/2107B 4K DYNAMIC RAM	$ 4.25
TMS 4050L	$ 3.96
5204-4K PROM	$10.95
82S23	$ 1.96
AY-5-1013 UART	$ 6.95
8703C TELEDYNE 3 STAGE BINARY 8 BIT A/D CONVERTER	$13.50
8080A	$11.95

AP BOARDS USED FOR SOLDERLESS BREADBOARDING

264L — 128 FIVE-TIE POINT TERMINALS	$12.50
212R — POWER BOARD	$ 2.50
2248L — 96 FIVE-TIE POINT TERMINALS	$10.00
209R — POWER BOARD	$ 2.25

IC TEST CLIPS
TC-14 — $4.50 TC-16 — $4.75

CTS 206-8 eight position dip switch $1.90
CTS-206-4 four position dip switch $1.45
LIGHT ACTIVATED SCR's TO-18, 200V 1A . . . . $ 1.10

SILICON SOLAR CELLS

2¼″ diameter .4V at 500 ma $4.00

LED READOUTS

FND 359 C.C. .4″	$ .50
FCS 8024 - 4 digit C.C. 8″ display	$5.95
FND 503 C.C. .5″	$ .85
FND 510 C.A. .5″	$ .85
DL-704-.3″ C.C.	$ .85
DL-704 C.A. .3″	$ .85
DL 747 C.A. .6″	$1.65
FND 800 C.C. .8″	$1.95
FND 807 C.A. .8″	$1.95

PRINTED CIRCUIT BOARD

4-1/2″x6-1/2″ SINGLE SIDED EPOXY BOARD 1/16″ thick, unetched
$.60 ea. . . . . 5/$2.60

7 WATT LD-65 LASER DIODE IR $8.95

2N 3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG. UJT	$ .65

MINIATURE MULTI-TURN TRIM POTS
100, 1K, 2K, 5K, 10K, 25K, 50K, 100K, 200K, 500K, 1Meg, 2Meg, $.75 each 3/$2.00

CHARGED COUPLE DEVICES

CCD 321 AH2-512 Analog Shift Register	$95.00
CCD 201C 100x100 Image Sensor	$95.00
CCD 202C 100x100 ImageSensor	$145.00

VERIPAX PC BOARD $4.00
This board is a 1/16″single sided paper epoxy board, 4½″x6½″ DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8,16 or LSI DIP IC's with busses for power supply connector.

FP 100 PHOTO TRANS	$ .50
RED, YELLOW, GREEN or AMBER LARGE LED's .2″	6/$1.00
TIL-118 OPTO-ISOLATOR	$ .75
MOLEX PINS	100/$1.00
	1000/$8.00
10 WATT ZENERS 3.9, 4.7, 5.6, 8.2, 18,22,100,150 or 200V	ea. $ .60
1 WATT ZENERS 4.7, 5.6, 10, 12, 15 18 or 22V	ea. $ .25
MC6860 MODEM CHIP	$9.95
MCM 6571A 7 x 9 character gen	$10.75

Silicon Power Rectifiers

PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.30	.80	3.70	5.00
200	.07	.20	.35	1.15	4.25	6.50
400	.09	.25	.50	1.40	6.50	9.50
600	.11	.30	.70	1.80	8.50	12.50
800	.15	.35	.90	2.30	10.50	16.50
1000	.20	.45	1.10	2.75	12.50	20.00

SAD 1024-a REDICON 1024 stage analog "Bucket Brigade" shift register. $18.95

IN 4148 (IN914) . . . . . 15/$1.00

RS232 CONNECTORS

DB 25P male $2.95
DB 25S female $3.50

REGULATORS

309K	$ .95
723	$ .50
LM 376	$ .60
320K-5, 12 or 15V	$1.00
320T-5, 15 or 24V	$ .95
340K-12,15 or 24V	$ .95
340T-5, 6, 8, 12 15,18 or 24V	$ .95
78 MG	$1.35
79 MG	$1.35

TRANSISTOR SPECIALS

2N6233-NPN SWITCHING POWER	$ 1.95
MRF-8004 a CB RF Transistor NPN	$ 1.50
2N3772 NPN Si TO-3	$ 1.00
2N1546 PNP GE TO-3	$ .75
2N4908 PNP Si TO-3	$ 1.00
2N6056 NPN Si TO 3 Darlington	$ 1.70
2N5086 PNP Si TO-92	4/$ 1.00
2N3137 NPN Si RF	$ .85
2N3919 NPN Si TO-3 RF	$ 1.50
2N1420 NPN Si TO 54	3/$ 1.00
2N3767 NPN Si TO-66	$ .70
2N2222 NPN Si TO-18	5/$ 1.00
2N3055 NPN Si TO-3	$ .50
2N3904 NPN Si TO-92	5/$ 1.00
2N3906 PNP Si TO-92	5/$ 1.00
2N5296 NPN Si TO-220	$ .50
2N6109 PNP Si TO-220	$ .55
2N3638 PNP Si TO-5	5/$ 1.00

TTL IC SERIES

7400–	.13	7445–	.65	74151–	.61
7401–	.13	7446–	.68	74153–	.61
7402–	.13	7447–	.58	74154–	.94
7403–	.13	7448–	.68	74155–	.58
7404–	.15	7450–	.15	74157–	.55
7405–	.13	7472–	.25	74161–	.55
7406–	.16	7473–	.28	74163–	.55
7407–	.20	7474–	.28	74164–	.85
7408–	.18	7475–	.45	74165–	.95
7409–	.18	7476–	.30	74170–	1.68
7410–	.13	7480–	.31	74173–	1.20
7411–	.18	7483–	.65	74174–	.95
7412–	.13	7485–	.87	74175–	.85
7413–	.36	7486–	.28	74176–	.75
7414–	.60	7490–	.42	74177–	.75
7416–	.22	7491–	.58	74180–	.65
7417–	.25	7492–	.43	74181–	1.90
7420–	.13	7493–	.43	74190–	1.00
7425–	.25	7494–	.67	74191–	1.00
7426–	.22	7495–	.65	74192–	.79
7427–	.19	7496–	.65	74193–	.79
7430–	.13	74107–	.28	74194–	.80
7432–	.22	74121–	.29	75325–	1.50
7437–	.21	74122–	.38	74196–	.86
7438–	.21	74123–	.45	74279–	.55
7440–	.13	74125–	.40	74367–	.65
7441–	.70	74126–	.40	75491–	.50
7442–	.37	74150–	.94	75492–	.50

DATA CASSETTES $ .95

44 Pin Solder Tail .156″ Connector $1.95

MM 5387AA new clock chip which will directly drive LED's 12/24 hrs., 1 supply & alarm $5.95

NO. 30 WIRE WRAP WIRE SINGLE STRAND 100′ $1.40

ALCO MINIATURE TOGGLE SWITCHES

MTA 106 SPDT	$ 1.05
MTA 206 DPDT	$ 1.70
MTA 206 P-DPDT CENTER OFF	$ 1.85
MSD 206 P-DPDT CENTER OFF LEVER SWITCH	$ 1.85

Full Wave Bridges

PRV	2A	6A	25A
100			1.30
200	.75	1.25	2.00
400	.95	1.50	3.00
600	1.20	1.75	4.00

DIP SOCKETS

8 PIN	.17	24 PIN	.35
14 PIN	.20	28 PIN	.40
16 PIN	.22	40 PIN	.60
18 PIN	.25		

SANKEN AUDIO POWER AMPS

Si 1010 G 10 WATTS	$ 7.80
Si 1020 G 20 WATTS	$15.70
Si 1050 G 50 WATTS	$28.50

TANTULUM CAPACITORS

.22UF	35V	5/$1.00	6.8UF	35V	4/$1.00
.47UF	35V	5/$1.00	10UF	10V	$ .25
.68UF	35V	5/$1.00	22UF	25V	$ .40
1UF	35V	5/$1.00	15UF	35V	3/$1.00
2.2 UF	20V	5/$1.00	30UF	6V	5/$1.00
3.3UF	35V	4/$1.00	47UF	20V	$ .35
4.7UF	15V	5/$1.00	68 UF	15V	$ .50

74LS SERIES

74LS00 –	.20	74LS132 –	.70
74LS02 –	.21	74LS138 –	.70
74LS03 –	.21	74LS139 –	.70
74LS04 –	.23	74LS151 –	.65
74LS05 –	.24	74LS153 –	.65
74LS08 –	.23	74LS155 –	.62
74LS09 –	.23	74LS156 –	.62
74LS10 –	.20	74LS157 –	.62
74LS11 –	.20	74LS160 –	.80
74LS13 –	.40	74LS161 –	.60
74LS14 –	.80	74LS162 –	.80
74LS15 –	.25	74LS163 –	.80
74LS20 –	.22	74LS168 –	.80
74LS21 –	.22	74LS169 –	.80
74LS22 –	.22	74LS170 –	1.60
74LS26 –	.30	74LS173 –	1.00
74LS27 –	.25	74LS174 –	.75
74LS28 –	.32	74LS175 –	.75
74LS30 –	.21	74LS181 –	2.00
74LS32 –	.32	74LS190 –	.90
74LS37 –	.30	74LS191 –	.90
74LS38 –	.30	74LS192 –	.90
74LS40 –	.25	74LS193 –	.90
74LS42 –	.60	74LS195 –	.50
74LS47 –	.73	74LS196 –	.75
74LS51 –	.25	74LS197 –	.75
74LS54 –	.25	74LS221 –	1.00
74LS73 –	.35	74LS257 –	.70
74LS74 –	.35	74LS258 –	.70
74LS75 –	.50	74LS265 –	.75
74LS76 –	.35	74LS279 –	.50
74LS85 –	1.00	74LS290 –	.60
74LS86 –	.35	74LS293 –	.60
74LS90 –	.50	74LS365 –	.52
74LS92 –	.50	74LS366 –	.52
74LS93 –	.50	74LS367 –	.52
74LS109 –	.35	74LS368 –	.52
74LS112 –	.35	74LS375 –	.60
74LS113 –	.35	74LS386 –	.35
74LS114 –	.35	74LS390 –	1.50
74LS125 –	.45	74LS670 –	2.00
74LS126 –	.45		

LINEAR CIRCUITS

LM 101	– .75
LM 301/748	.29
LM307	– .30
LM308	– .75
LM311	– .75
LM318	– 1.20
LM319	– .95
LM 324	– 1.05
LM339	– 1.10
LM 358	– .70
LM370	– 1.15
LM377	– 2.50
LM 380	– .95
LM381	– 1.25
LM 382	– 1.25
LM537	– 2.50
LM 553	– 2.50
LM 555	– .39
LM556	– .85
NE540L	– 2.25
560	– 2.00
565	– .95
566	– 1.25
567	– 1.30
703	– .90
709	– .25
710	– .35
741C or V	– .31
747	– .50
LM1310	– 2.50
1456	– .95
1458	– .50
CA3046	– .75
3900	– .49
8038CC	– 3.90
791	– 1.95
LF356H	– 1.20

TRIACS / SCR'S

PRV	TRIACS 1A	TRIACS 10A	TRIACS 25A	SCR'S 1.5A	SCR'S 6A	SCR'S 35A
100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
600	1.70	2.30	3.60		1.50	3.00

Terms: FOB Cambridge, Mass. Send Check or Money Order. Include Postage, Minimum Order $5.00, COD'S $20.00

Send 25¢ for our catalog featuring Transistors and Rectifiers
145 Hampshire St., Cambridge, Mass.



SOLID STATE SALES
P.O. BOX 74B
SOMERVILLE, MASS. 02143 TEL. (617) 547-7053

WE SHIP OVER 95% OF OUR ORDERS THE DAY WE RECEIVE THEM

Circle 340 on inquiry card.

Reader Service

To get further information on the products advertised in BYTE, fill out the reader service card with your name and address. Then circle the appropriate numbers for the advertisers you select from the list. Add a 13 cent stamp to the card, then drop it in the mail. Not only do you gain information, but our advertisers are encouraged to use the marketplace provided by BYTE. This helps us bring you a bigger BYTE.

**Correspond directly with company.*

BOMB—BYTE's Ongoing Monitor Box

Readers Tune In to Ciarcia

The winner of the April BOMB is Steve Ciarcia's "Tune In and Turn On: A Computerized Wireless AC Control System, Part 1," page 114. Second prize goes to Ernest W Kent's "The Brains of Men and Machines, Part 4: The Machinery of Emotion and Choice," page 66. The authors will receive prizes of $100 and $50, respectively.

The BOMB (BYTE's Ongoing Monitor Box) is your way of telling us what you think about the articles in BYTE each month. To cast your votes, see the card on the opposite page.■



READER SERVICE

July 1978
4178

For fastest service transfer mailer label from wrapper to coupon provided at the right. Requests cannot be honored unless zip code is given. This card valid for 90 days only.

NOTE—If label is missing or defaced fill out coupon carefully —PLEASE PRINT—this is only way to get requested material to you.

Name ______________________

(Title) ______________________

(Company) ______________________

Address ______________________

City ______________ State ________ Zip ________

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	321	341	361	381	401	421	441	461	481	501	521	541	561	581	601	621	641
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	322	342	362	382	402	422	442	462	482	502	522	542	562	582	602	622	642
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	323	343	363	383	403	423	443	463	483	503	523	543	563	583	603	623	643
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	324	344	364	384	404	424	444	464	484	504	524	544	564	584	604	624	644
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	325	345	365	385	405	425	445	465	485	505	525	545	565	585	605	625	645
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	326	346	366	386	406	426	446	466	486	506	526	546	566	586	606	626	646
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	327	347	367	387	407	427	447	467	487	507	527	547	567	587	607	627	647
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	328	348	368	388	408	428	448	468	488	508	528	548	568	588	608	628	648
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	329	349	369	389	409	429	449	469	489	509	529	549	569	589	609	629	649
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	330	350	370	390	410	430	450	470	490	510	530	550	570	590	610	630	650
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	331	351	371	391	411	431	451	471	491	511	531	551	571	591	611	631	651
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	332	352	372	392	412	432	452	472	492	512	532	552	572	592	612	632	652
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	333	353	373	393	413	433	453	473	493	513	533	553	573	593	613	633	653
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	334	354	374	394	414	434	454	474	494	514	534	554	574	594	614	634	654
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	335	355	375	395	415	435	455	475	495	515	535	555	575	595	615	635	655
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296	316	336	356	376	396	416	436	456	476	496	516	536	556	576	596	616	636	656
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297	317	337	357	377	397	417	437	557	577	497	517	537	557	577	597	617	637	657
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298	318	338	358	378	398	418	438	458	478	498	518	538	558	578	598	618	638	658
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299	319	339	359	379	399	419	439	459	479	499	519	539	559	579	599	619	639	659
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	620	640	660

MENTION  WHEN WRITING TO ADVERTISERS

BYTE SUBSCRIPTIONS

4178

For a subscription to BYTE, please complete this card.

Name ______________________

Address ______________________

City ______________________

State ________ Zip ________ Country ______________

	USA	Canada Mexico
☐ 1 year	☐ $15	☐ $17.50
☐ 2 years	☐ $27	☐ $32.00
☐ 3 years	☐ $39	☐ $46.50

☐ $25 Europe (air freight) payment enclosed
☐ $25 Elsewhere (surface mail) payment enclosed
(Air mail rates available upon request)

Please remit in US funds— Thank you.

☐ Check enclosed (**Bonus:** one EXTRA issue — receive 13 issues for the price of 12)

☐ VISA ☐ ☐ Bill me (US only)

Card No. ______________________

Expiration date ______________________

Four digits above name — Master Charge only ______________

Signature ______________________ Date ________

Please allow eight weeks for processing. *Thank you*

BOMB: BYTE's Ongoing Monitor Box

4178

BYTE's BOMB is your direct line to the editor's desk. Each month, the two top rated authors receive bonuses based on your votes. To use this card, refer to the list of authors, titles, and corresponding BOMB article numbers on the opposite page. Then rate each article on a scale from 0 to 10 below by circling the appropriate rating number to the right of each BOMB article number. Your feedback helps us produce the best possible magazine each month.

.... Rating ....

BOMB Article Number	Poor		Fair		Good		Very Good		Excellent		Wow!
1	0	1	2	3	4	5	6	7	8	9	10
2	0	1	2	3	4	5	6	7	8	9	10
3	0	1	2	3	4	5	6	7	8	9	10
4	0	1	2	3	4	5	6	7	8	9	10
5	0	1	2	3	4	5	6	7	8	9	10
6	0	1	2	3	4	5	6	7	8	9	10
7	0	1	2	3	4	5	6	7	8	9	10
8	0	1	2	3	4	5	6	7	8	9	10
9	0	1	2	3	4	5	6	7	8	9	10
10	0	1	2	3	4	5	6	7	8	9	10
11	0	1	2	3	4	5	6	7	8	9	10
12	0	1	2	3	4	5	6	7	8	9	10
13	0	1	2	3	4	5	6	7	8	9	10
14	0	1	2	3	4	5	6	7	8	9	10
15	0	1	2	3	4	5	6	7	8	9	10
16	0	1	2	3	4	5	6	7	8	9	10
17	0	1	2	3	4	5	6	7	8	9	10
18	0	1	2	3	4	5	6	7	8	9	10
19	0	1	2	3	4	5	6	7	8	9	10
20	0	1	2	3	4	5	6	7	8	9	10

Comments ______________________

PLACE
STAMP
HERE



READER SERVICE

PO Box 319
Dover NJ 07801
USA

BOMB—
BYTE's Ongoing Monitor Box

BYTE Publications Inc
70 Main St
Peterborough NH 03458
USA

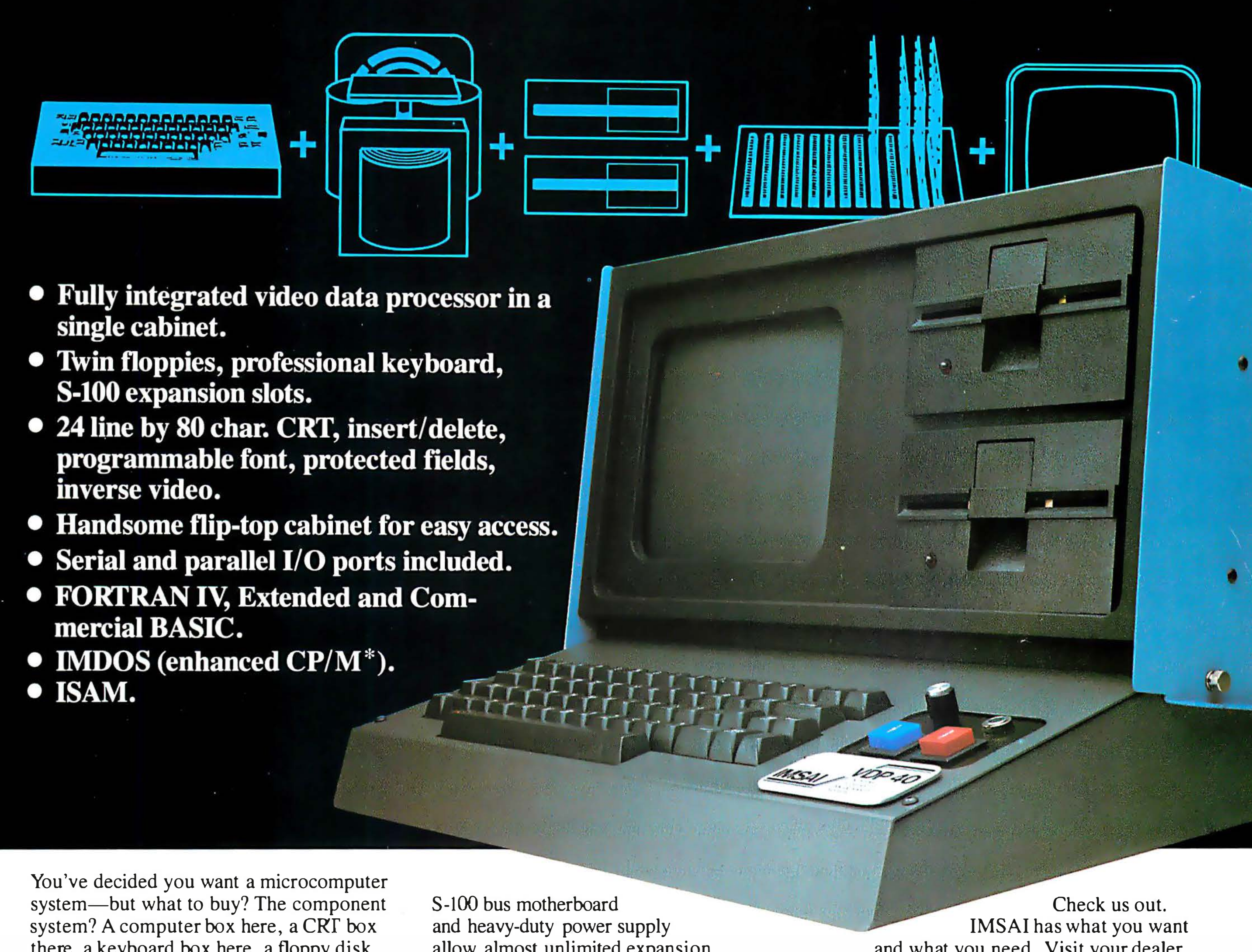
PLACE
STAMP
HERE

BYTE SUBSCRIPTIONS
PO Box 590
Martinsville NJ 08836
USA

PLACE
STAMP
HERE

Microcomputer System Solution.

Announcing the IMSAI VDP-40.



You've decided you want a microcomputer system—but what to buy? The component system? A computer box here, a CRT box there, a keyboard box here, a floppy disk box there . . . Messy! The $695 system? But . . . no disk; no way to add enough memory . . . and, if you could, it's not so cheap anymore, and you still wind up with an expensive box collection anyway. Messy!

The IMSAI VDP-40, a fully integrated Video Data Processing system that, in one handsome package, combines a professional keyboard, heavy-duty power supply, twin mini-floppies, multi-slotted motherboard and 9-inch CRT at a new low price.

System Expansion? The IMSAI VDP-40 was built for you. The extra slots in our S-100 bus motherboard and heavy-duty power supply allow almost unlimited expansion. Need more RAM? Add up to ½ MByte with our Intelligent Memory Manager and 64K RAM boards. Need more disk storage? A controller option of the VDP-40 will allow you to expand to nearly 5 megabytes! Add a line printer, an IBM-compatible tape drive, a MODEM! IMSAI has them all, with the interfaces and software to make it work for you. The standard of excellence IMSAI places at your disposal at a price/performance no one else has put together allows you to achieve the full potential of your imagination.

Check us out. IMSAI has what you want and what you need. Visit your dealer or write us directly. Ask about the IMSAI VDP-40 and the entire IMSAI line.

Features and prices subject to change without notice.
*CP/M is a trademark of Digital Research Corporation.

IMSAI®

The Standard of Excellence in Microcomputer Systems

IMSAI Manufacturing Corporation,
Dept. EWN, 14860 Wicks Boulevard,
San Leandro, CA 94577 (415) 483-2093

IMSAI EUROPE Europa Terrassen 8 Rue Jean Engling Dommeldange, Luxembourg 43-67-46 Telex: 1428

See us at the NCC Show, booth 2860

Price/Performance no one else has put together.

Circle 175 on inquiry card.

This 8-bit machine, by itself, is as versatile as a lot of systems that include peripherals



Skeptical? For starters, because of its unique design the H8 is the only machine in its price class that offers full system integration yet, with just 4K of optional memory and using only its "intelligent" front panel for I/O, may be operated completely without peripherals!



In addition, by using the features of its built-in Pam-8 ROM panel control program, the H8 actually allows you to dig in and examine machine level circuitry.

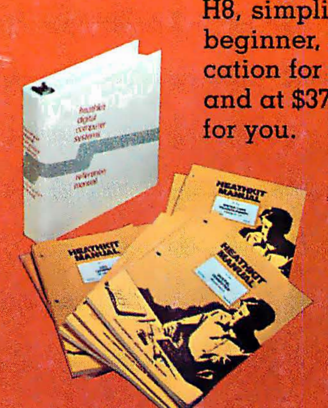
Responding to simple instructions the "intelligent" panel displays memory and register contents, lets you inspect and alter them even during operation. And for greater understanding, the front panel permits you to execute programs a single instruction at a time. The result is a powerful, flexible learning tool that actually lets you "see" and confirm each detail of H8's inner workings.

If you need further evidence, consider the fact that H8's system orientation allows you an almost unlimited opportunity for growth.

Memory is fully expandable, the 8080A CPU extremely versatile, and with the addition of high speed serial and parallel interfacing you gain the added flexibility of I/O operation with tape, CRT consoles, paper tape reader/punches, and now our new floppy disk systems!

The H8 offers superior documentation including complete step-by-step assembly and operation manuals, is backed by 54 years of Heath reliability, and comes complete with BASIC, assembler, editor, and debug software – others charge over $60 for!

H8, simplicity for the beginner, sophistication for the expert and at $375* just right for you.



*Prices are mail order net FOB, Benton Harbor, Michigan. Prices and specifications subject to change without notice.

Be sure to use coupon on page 34 of this magazine to order your FREE Heathkit Catalog!



HEATHKIT COMPUTERS

System Engineered for Personal Computing

H8



Circle 160 on inquiry card.